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Addressing Cross Border E-commerce Challenges with Emerging Technologies

Project Report

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The Borders, Trade, and Immigration Institute

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Led by the University of Houston

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Executive summary

The e-commerce marketplace has spurred increased competition, lower prices, and more variety. By offering ease of access and more ways by which transactions can be completed, e-commerce is fast becoming the platform that consumers and businesses use to access global markets. Research estimates that e-commerce accounts for 12% of global trade of physical goods, both business-to-business (B2B) and business-to-consumer (B2C or retail) sales. The U.S. International Trade Commission reports global e-commerce totaled over $27 trillion in 2016, with B2B comprising over 85% of that total.

There are specific gaps and challenges for CBP to obtain complete and accurate data of cross-border e-commerce shipments, such as: (i) data held by intermediaries; (ii) seller or intermediary without physical presence; (iii) fragmented data; and (iv) low data quality. All result in insufficient data for Customs authorities to achieve efficient processing of cross-border e-commerce import transactions, and shipments.

This report assesses options to address e-commerce data sharing challenges, how to leverage emerging technologies to augment and enhance data sharing, the economic costs and benefits from incorporating emerging technologies, and improved risk assessment and targeting capabilities for CBP. Options to address e-commerce data sharing challenges include:

- Developing a new AEO program tailored for the cross-border e-commerce environment.
- Allowing trusted intermediaries or online sellers to receive AEO certification by demonstrating compliance with Customs requirements and cooperating with other e-commerce stakeholders.
- Taking into account the challenges of Micro, Small, and Medium Size Enterprises (MSMEs).

- Designing effective e-commerce AEO programs that require data sharing despite emerging data localization laws.
- Creating a federated data platform and ICT infrastructure.

Technologies such as artificial intelligence/machine learning, digital distributed ledgers, and linked data-related technologies could bring benefits including improved data quality, reduced labor cost for both intermediaries and sellers, increased automation, enriched data sources, enhanced data interoperability, reduction of fraud, and improved accountability.

Our economic analytical framework employs a risk-based model to assess the costs and benefits for stakeholders of moving from the current data sharing system to a digital distributed ledger in a customs environment. The findings from this detailed analytical approach suggest that leveraging advanced data sharing options like digital distributed ledger technology will have the following effects:

- The share of shipments where the stakeholders cooperate and share sufficient data for expedient entry will increase.
- The probability that CBP and other regulatory agencies will obtain sufficient data for expedited entry will increase.
- The number of shipments where stakeholders do not share sufficient data will decrease.
- Landed costs are not significantly affected by digital distributed ledger technology costs.
- An increase in the economic efficiency of the importing process with the digital distributed ledger customs environment. This encompasses the efficiency effects for the consumer, the importer, and other stakeholders.

Linked open data in e-commerce can improve risk assessment and targeting capabilities for CBP by capturing data from original and heterogeneous data resources. Advanced data sharing would allow the Customs authorities to link parcel shipments with marketplaces, sellers' online stores, and products listed on marketplaces. In addition, linked data standards and technologies create opportunities to construct knowledge-based databases for e-commerce from public data sources (both structured data and unstructured data). The ability to share sufficient data for expedited e-commerce entry processing and incentives to do so both increase, and the economic efficiency of the importing process improves. The all-stakeholder data sharing model can also be applied to postal delivery of e-commerce packages and parcels.

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Problem definitions

The e-commerce marketplace has spurred increased competition, lower prices, and more variety. By offering ease of access and more ways by which transactions can be completed, e-commerce is fast becoming the platform that consumers and businesses use to access global markets. Research estimates that e-commerce accounts for 12% of global trade of physical goods, both Business to Business (B2B) and Business to Consumer (B2C) sales. The United States International Trade Commission (USITC) reports global e-commerce totaled over $27 trillion in 2016. In 2018, 1.8 billion people globally purchased goods online, and 57% of online buyers purchase from foreign sellers [16].

USITC further reports that China ($767 million) and the United States ($595 million) are the top B2C e-commerce markets [10]. As far as U.S. imports in this area, CBP(U.S. Customs and Border Protection, Office of Trade) records show that e-commerce resulted in nearly a 50% increase in express consignment billings in five years (2012-2017) and a 300% increase in international mail [53]. In fiscal year 2013, CBP processed 150 million international mail shipments and by fiscal 2017 that number had risen to over 500 million shipments [53].These increases are driven by e-commerce as well as other factors such as macroeconomic and trade fluctuations.

The appetite for e-commerce is global. One-quarter of the world's population purchased goods and services online in 2017 [41]. Indeed, the expansion of online sales has created a trade environment where almost everybody can be a global seller and/or a global buyer. E-commerce platforms provide a way for Micro, Small and Medium Enterprises (MSME) to grow by reaching customers across the country and the world. E-commerce platforms offer online services to match shoppers to suppliers, facilitate ordering, accept payments, and coordinate the physical logistics and delivery of goods.

The process stands in great contrast with the traditional, mainly containerized, trade where most of the volumes are shipped in large quantities between a limited number of sellers and buyers. In e-commerce supply chains, large shares of goods are sold online as one time sales in small quantities, and shipped in small packages or parcels. For instance, upon

flight arrival, ground handlers unload inbound mail and bring it to the United States Postal Service (USPS), the mail and parcels are scanned for radiation, and then USPS is required to present all the inbound mail to CBP for inspection. CBP clears mail and then routes it back to USPS, which processes the cleared mail for delivery.

Without an established retailer, there is less likely to be a regular importer or an established, licensed customs broker who submits a proper filing to CBP. Receiving reduced or improper information decreases CBP's ability to fulfill its missions for import security, revenue collection, and trade facilitation [30]. Requiring advanced electronic data for postal shipments can help to mitigate these risks. Notwithstanding, there remain risks to the global supply chains in the form of a trade violation, release of harmful goods to the commerce, or a potential safety hazard.

As shown in the World Customs Organization (WCO) report [56], Customs authorities around the world are struggling with many data related issues brought by e-commerce importation. These include, lack of pre-arrival information of imported goods purchased from e-commerce websites, incomplete information of low valued e-commerce shipment (for instance, goods below the de minimis threshold), incorrect and poor quality data from casual or inexperienced importers, etc. There is no guarantee of accuracy or quality of the information, for instance, regarding third-party sellers' identities [1], identities of manufacturers, product identifiers (e.g., UPC, GTIN) , product classification , PGA required certifications .

A large percentage of sellers on e-commerce marketplaces are third-party sellers. For example, according to a study by Wall Street Journal (WSJ) [7] in Aug 2019, third-party sellers have exploded on Amazon e-commerce marketplace, jumping to nearly 60% of physical merchandise sales in 2018 from 30% a decade ago. As a result, it becomes increasingly difficult to check and verify product information posted by the third-party sellers. Just based on a subset of samples, the WSJ investigation identified 4,152 unsafe items on sale and discovered that 116 products were falsely listed as "FDA-approved" [2] and 52 listings were marketed as supplements with brand names that the Food and Drug Administration (FDA) and Justice Department have identified as containing illegally imported prescription drugs [3].

It is common that products listed on e-commerce websites contain false claims, fake product labels, etc. For instance, sellers of counterfeited products often copy UPC code from legitimate vendors. Some e-commerce websites allow Intellectual Property Right (IPR) owners to identify bad third-party actors. The process is cumbersome, and often requires the IPR owners to first purchase counterfeits for verification. On the other hand, bad actors

[1] E-commerce platforms adopt diverse vetting practice to control who may list products on their sites for sale. Some platforms scrutinize their sellers more than others (require detailed information, such as an existing online presence, proof that the seller is a business entity) while some others allow anyone to sell a product if they can provide some basic information about themselves.

[2] These include toys listed as "FDA-approved" and the agency does not approve toy; and 98 eyelash-growth serums that never undertook the drug approval process to be marketed as approved.

[3] FDA warning letters can be found in https://www.fda.gov/inspections-compliance-enforcement-and-criminal-investigations/compliance-actions-and-activities/warning-letters

can continue to open many new accounts on different e-commerce platforms and marketplaces.

Currently there is no way to know when a parcel arrives at a U.S. port of entry from which website it was purchased. Such data challenges weaken Customs authority's capability to implement proper control on e-commerce importation. Without sufficient information, Customs authority may find it difficult to realize risk based management and perform targeting effectively.

On top of that, e-commerce vendors often provide vague or sometimes misleading goods descriptions. Additionally, non-traditional, less knowledgeable importers may, knowingly or unknowingly, circumvent U.S. import laws with incorrect customs classifications. All these lead to potentially dangerous imports, and compromise import safety and security [7].

E-commerce into Customs Declaration

E-commerce is a growing segment of U.S. imports. While there is no official estimate of the share of e-commerce in U.S. imports, according to the U.S. Consumer Product Safety Commission (USCPSC), 38 percent of the total value of U.S. imports under the agency's jurisdiction can be attributed to e-commerce (USCPSC Nov 2019). According to CBP Acting Commissioner Mark A. Morgan as well as industry leaders like CBP LAX Area Port Director LaFonda Sutton-Burke, e-commerce shipments have the potential to be some of the most at-risk for illicit or counterfeit goods. As e-commerce becomes more seamlessly integrated with the customs declaration process, customs officials and other interested parties like FDA and ICE are more likely to obtain sufficient data and information. Programs to try and address these issues have included the Section 321 data pilot and entry type 86.

The cost burden of not sharing data falls heavily on those who do share necessary data. For instance, not sharing sufficient data on a product, sending in counterfeit/illicit products, or other inefficient behaviors for speedy entry can lead to economic damages for legitimate U.S. businesses in several ways. Legitimate incoming products can get held up inadvertently with higher dwell times as CBP attempts to address the illicit shipments or those with insufficient information. For instance, in contrast to bad actors who send illicit shipments that pose unfair competition or safety hazards to U.S. consumers, there are good actors that may not have the data readily available to share in an efficient and speedy way due to their business model. Enhanced e-commerce integration into customs declaration with new technologies can facilitate efficient data sharing by good actors.

A key driver of cost in the shipping process is dwell time, which is the amount of time a package is held by CBP or other government agencies pending release to the U.S. consumer/importer. Dwell time effectively creates a wedge between the price the importer pays, and the exporter receives. The longer legitimate packages are held at various importing agencies, the greater the economic inefficiencies and costs.

The Trade Facilitation and Trade Enforcement Act of 2015 (TFTEA) amended the Tariff Act of 1930 and Title 19 of the United States Code Section 321 to raise the de minimis value

from $200 to $800 [52]. Raising the de minimis to $800 has increased the number of duty-free eligible imports, lowered costs to importers, and simplified the import process for low valued cross-border shipments [35]. As such, the increased volume of de minimis packages that do not require a full set of data to be filed with CBP has presented challenges along with the overall increase in small, non-containerized trade facilitated by e-commerce.

For instance, consider the bicycle market. The higher de minimis threshold combined with online foreign retail has led to increased shipments of bicycles, bicycle components, helmets, and other related products from abroad, namely China [43]. Consumers have enjoyed lower prices and greater variety, but also have unknowingly purchased bicycles and products that do not meet product and safety standards. Consumers are at risk when the products they purchased online from a foreign retailer do not meet product and safety standards, or are counterfeit products. U.S. domestic producers are at risk of unfair competition when the incoming products circumvent U.S. trade rules and domestic regulations.

These risks appear to have increased in recent years with the higher de minimis threshold, which raised the valuation threshold for duties and to some extent customs examination. This study sought to define how CBP could re-engineer the entry process to close the loopholes created by the higher de minimis threshold, ensure incoming e-commerce imports meet product and safety standards, are not counterfeit, and comply with the U.S. trade policy. This study also sought to draw lessons learned from CBP e-commerce pilots (e.g., Section 321 Data Pilot).

Re-engineering the process will come with higher costs for the exporter and possibly the importer. Compliance costs may be higher at first, and then once the new rules are internalized for each entity, compliance costs would be expected to diminish. For those exporters that are in full compliance, their costs will be adopting to new entry rules. Other exporters will be faced with the option of taking measures to achieve full compliance or reducing exports to the United States.

3

Project objectives

The objectives should address these challenges by leveraging recent advances of technologies such as distributed ledgers and artificial intelligence as the integrated environment to tackle high priority issues that CBP is facing. Some unique characteristics of the effort can be summarized below:

- This project aimed to address the e-commerce data challenges that CBP and e-commerce stakeholders are facing such as data completeness, data quality, and data linkages among e-commerce marketplaces, sellers, e-commerce transactions, globally unique product identities (e.g., UPC, EAN, GTIN), shipping labels, and product information.
- This project was designed to align with DHS's overall strategies such as recommendations laid out in [12], a report released in early 2020 by DHS, Office of Strategy, Policy & Plans regarding e-commerce. In particular, the project efforts were aligned with the immediate actions for the U.S. government suggested in the report including: ensure entities with financial interests in imports bear responsibility; increase scrutiny of Section 321 environment; and create modernized e-commerce enforcement framework.

The efforts aim at increasing knowledge and understanding how new emerging technologies can enhance Customs authority's capabilities to facilitate cross border e-commerce and shipment without compromising Customs administration's ability to uphold import safety and security law, and protect the nation's commerce from harmful goods. The efforts may provide guidance and valuable inputs for future government policies and plans on applying technologies for trade facilitation. The results will also inform global e-commerce stakeholders with findings and discoveries that may pave a road for globally coordinated efforts to develop data exchange standards for cross-border e-commerce.

This study would examine how CBP could close the loopholes created by the higher de minimis threshold, ensure incoming e-commerce imports meet product and safety standards,

are not counterfeit, and comply with US trade policy. This can be achieved by taking advantage of emerging technologies and their applications to solve challenges faced by CBP and partner agencies, which includes distributed ledgers [43], artificial intelligence/machine learning, big e-commerce data as well as synergy among such technology components. A recent report by the Congressional Research Service on Digital Trade and U.S. Trade Policy [2] mentions three key emerging technologies for digital trade. They are: Internet of Things (IoTs), Blockchain [1], and Artificial Intelligence. Researchers have considered the potential role for blockchain technology in international trade, specifically trade finance, Customs, and provenance of goods [34].

Distributed ledger technology holds a unique potential for solving the e-commerce data challenges due to its characteristics such as distributed consensus, automatic synchronization of data, tamper resistance/tamper proof, strong protection of data integrity, cyber-attack resilience, auditability, etc. These properties make distributed ledgers ideally suited to support data cooperation, enable digital identity management for e-commerce (e.g., certification of authorized economic actors, digital identities of manufacturers, products, and vendors), and implement data exchange platforms in a distributed stakeholder environment such as global trade.

Leveraging distributed ledgers to reduce friction of information flow, Customs authority can gain access to accurate pre-shipment data of e-commerce transactions, which enables advanced risk analysis and more targeted control. Although e-commerce marketplaces are not necessarily involved in the goods flow depending on their business models, they are always engaged with the information flow. Existing practice relies on data from freight forwarders and carriers as intermediaries for customs declaration and may not be sufficient as they may not have direct access to accurate e-commerce data such as sales price, goods description, and third-party vendor/seller identity. Distributed ledger technology supports implementation of shared data pipes among e-commerce stakeholders. Data creators/owners (e.g., e-commerce platform providers, freight forwarders) can manage their own data without the needs of data duplication. Data synchronization is automated using distributed consensus. Such design has many advantages over the existing data communication protocols that rely on peer to peer communications, which hinders supply chain transparency and traceability.

In addition, AI and ML based approaches can be applied to automatically identify and classify products based on descriptions and multi-media information posted on e-commerce marketplaces. Computer clustering algorithms can automatically group products based on similarities (for instance, automatically compute and assign HTS code based on HTS code of similar products). Distributed ledgers can automatically integrate and harmonize classification databases from multiple sources. Classification process can be certified and recorded using distributed ledgers so that CBP and partner agencies can access and verify how products purchased from a particular e-commerce marketplace are classified.

An integrated environment (AI/ML plus distributed network of e-commerce product data sources) can be applied to match product listing with detailed product information - big

[1] In this report, we consider blockchain is an enabling technology for realizing distributed ledgers.

e-commerce data. This is extremely useful to detect bad actors and sellers of dangerous and/or counterfeit products.

The focus on "trusted data sources", data quality, and in-depth data cooperation can help Customs authority to address the data challenges for trade facilitation and risk based management. Because e-commerce stakeholders including marketplaces can lodge declarations before arrival of the goods, upon arrival, goods will either be immediately released or selected for inspection. This will increase predictability and certainty of e-commerce deliveries and hence their reputations among online purchasers.

There is a clear economic rationale to integrate the e-commerce data environment into customs declaration and entry process. Harmonizing e-commerce data flows with customs standards can facilitate data and information flows from warehouses and transport companies to platforms and agents, allow better security standards of e-commerce products and information flow, and cut the time costs of a non-standard system for e-commerce classifications. Furthermore, technology enhancement in that integration process could improve data quality, reduce labor costs, create more room for capital, enrich e-commerce data, decrease data fraud rates, and improve accountability. Reducing these labor and time costs and improving data quality have implications for importer and consumer costs as well as economic efficiency.

Last but not the least, the project aims at providing both the underlying economic analysis and a nontechnical summary of the key findings of the analysis of the costs and benefits of integrating distributed ledgers, machine learning, and other technologies into the e-commerce customs process. The economic effects will be considered for government agencies, private sector firms, and consumers. For instance, the economic effects for government agencies include how the integration of such emerging technologies may affect each agency's ability to accomplish their mission(s) and any corresponding changes in resources and costs. Business effects include changes in production and operation costs, ability to reach existing and new customers, and time savings (or costs). Consumer effects include changes in the prices of goods and services, the range of varieties available, the extent of information available, and consumer privacy.

4

Map e-commerce data flow

4.1. Background

Cross-border e-commerce refers to international commercial activities whose transaction involves parties residing in different countries, and conduct transactions through the e-commerce ecosystem. The ecosystem of cross-border e-commerce involves multiple intermediaries including marketplaces, distribution and fulfillment centers, logistics service providers, carriers, customs brokers, as well as online sellers and consumers. The process includes online product listing, online ordering, payment and settling, packaging and consolidation, shipping arrangement, going through procedures of customs clearance, tracking, and delivering the purchased commodities through cross-border logistics.

To map both the physical and data flows of e-commerce transactions, in addition to data collected by the project team from e-commerce intermediaries (e.g., API specifications, electronic data exchange protocols, developer manuals), the project team has used multiple sources of information including reports from WCO, COAC, CBP, and academic publications. This chapter provides a summary of the results.

4.2. Stakeholders and intermediaries

Marketplaces/platforms/portals: This category includes a wide group of service providers that act as online intermediaries for sellers to make offers and sell commodities. It includes marketplaces, such as Amazon, Alibaba, eBay, Walmart, Flipkart, Shopify, etc. With increasing popularity of social commerce that combines social network and social media platforms with e-commerce, which facilitates selling products directly within social media/network platforms, this category also includes social media platforms such as Facebook, Instagram, etc. For instance, a recent study suggests that 30% of online shoppers say they would like to buy directly from a social media network like Facebook, Pinterest,

Instagram, Twitter or Snapchat [36].

Logistics service providers: Logistics Service Provider (LSP) are companies which perform logistics activities on behalf of others. Logistics service providers have grown in importance in e-commerce as majority online sellers outsource their logistics functions to third party service providers who perform logistics planning, implementation, and controlling the flow of goods/commodities, services, and related information in e-commerce transactions. Depending on types of commodities sold online, business models, and magnitude of transactions, e-commerce sellers often employ different e-commerce logistics strategies when interacting with logistics service providers.

Fulfillment/distribution centers: Fulfillment centers are third-party warehouses responsible for handling goods on behalf of foreign suppliers/sellers. These are now commonly used by business for the distribution of their products (e.g., receiving, processing and delivering services), especially in the cross-border commerce context. Fulfillment centers receive customers' orders when they order certain product online. Then fulfillment centers pick and pack the goods, and ship to the customers. E-commerce fulfillment process involves multiple components including, getting products onto fulfillment center shelves and integration with e-commerce platforms, receiving and managing inventory, order fulfillment, and processing returned goods.

Fulfillment services provide businesses to start-ups and MSMEs that may not have the infrastructure and logistic facilities but also to large established enterprises, with many benefits, including lower shipping and operating costs, global delivery of goods, speed of delivery, improved customer service, and technology-intensive solutions (e.g., item tracking and information, carrier selection, integration with sales channels, etc).

In cross-border e-commerce, certain sellers and online platforms have adopted business models that rely on fulfillment centers and distribution centers in North America to provide space for foreign-made goods, followed by one-at-a-time order fulfillment process, which allows goods purchased online to be packed and shipped individually with reduced delivery time. This process often requires coordination with customs brokers and LSP to deliver goods to the fulfillment/distribution centers.

Payment service providers: A Payment Service Provider (PSP) offers online sellers the support that they need to access electronic payments. Typically, PSPs provide e-commerce merchants a single interface to accept one or multiple online payment methods (e.g., credit cards, money transfer). Examples of PSPs include PayPal and Stripe.

Shippers: Cross-border commodities purchased online are mostly shipped through services offered by consignment express shippers such as UPS, DHL, FedEX, or United Parcel Service. If shipped from a foreign warehouse or distribution center, a parcel containing goods purchased online will arrive at a U.S. port of entry under the authority of CBP, and partner agencies with authority to decide admissibility of various types of goods into the U.S (e.g., FDA, EPA). If the goods are admissible, they will be cleared and released for delivering to the customers. Due to growing popularity of e-commerce, millions of parcels

arrive daily, and the number has been increasing over the time. For instance, United States Postal Service (USPS) reported a 54% increase in inbound international mail volume from fiscal year 2012 to fiscal year 2016.

Cross-border e-commerce sellers: Cross-border e-commerce sellers refer to entities or individuals who sell products online using e-commerce to foreign customers. Due to complexity of e-commerce business models (e.g., B2C, C2C, B2B2C), e-commerce sellers include a broad range of stakeholders and players such as traditional retailers with online and e-commerce presence, thirty party sellers on e-commerce marketplaces, online resellers, online distributors, manufacturers who sell directly to customers through online intermediaries, or consumers who may act both as sellers and buyers on e-commerce platforms.

Customs and Cross Border Regulatory Agencies (CBRA): CBRA refers to regulatory and government agencies with authority to enforce trade laws, as well as manage, determine, process, and control flows of goods into (import) or out of (export) the U.S. This category includes CBP, Partner Government Agencies (PGA) - see Appendix F for a list agencies with data requirements for imports, etc.

Brokers: A customs broker refers to a private individual, partnership, association or corporation licensed, regulated and empowered by CBP to assist importers and exporters in meeting U.S. government requirements governing imports and exports. Brokers often assist their clients to prepare customs declarations that include necessary filing for cross-border e-commerce transactions. Services provided by brokers include entry procedures, admissibility requirements, classification, valuation, and the rates of duty and applicable taxes and fees for imported commodities or merchandises.

4.3. E-commerce data flow

Constituent elements of e-commerce transactions include the following conducted entirely via the internet.

- Listing of products by sellers on marketplaces or platforms.
- Purchase initiation and order agreement for a transaction facilitated by the payment service provider.
- Transaction facilitated by the payment service provider,

Whenever the goods purchased are physical goods, the subsequent phases involve physical flows between the seller and the buyer, possibly involving logistics service providers. To which extent an online seller outsources e-commerce activities to third party LSP and fulfillment service providers depends on many factors and e-commerce logistics strategies appropriate for the seller. There have been efforts to map flows of cross-border e-commerce

transactions. Appendix D illustrates e-commerce multi-modal supply chain flow, results of an investigation led by COAC E-commerce Working Group in 2019.

The project team has relied on multiple information sources (e.g., COAC E-commerce Working Group, WCO, electronic data protocols of intermediaries, project team's own data collection efforts, academic publications) in order to develop a process flow of e-commerce data that involves electronic data exchanges between major intermediaries and stakeholders. In this subsection, a summary is provided.

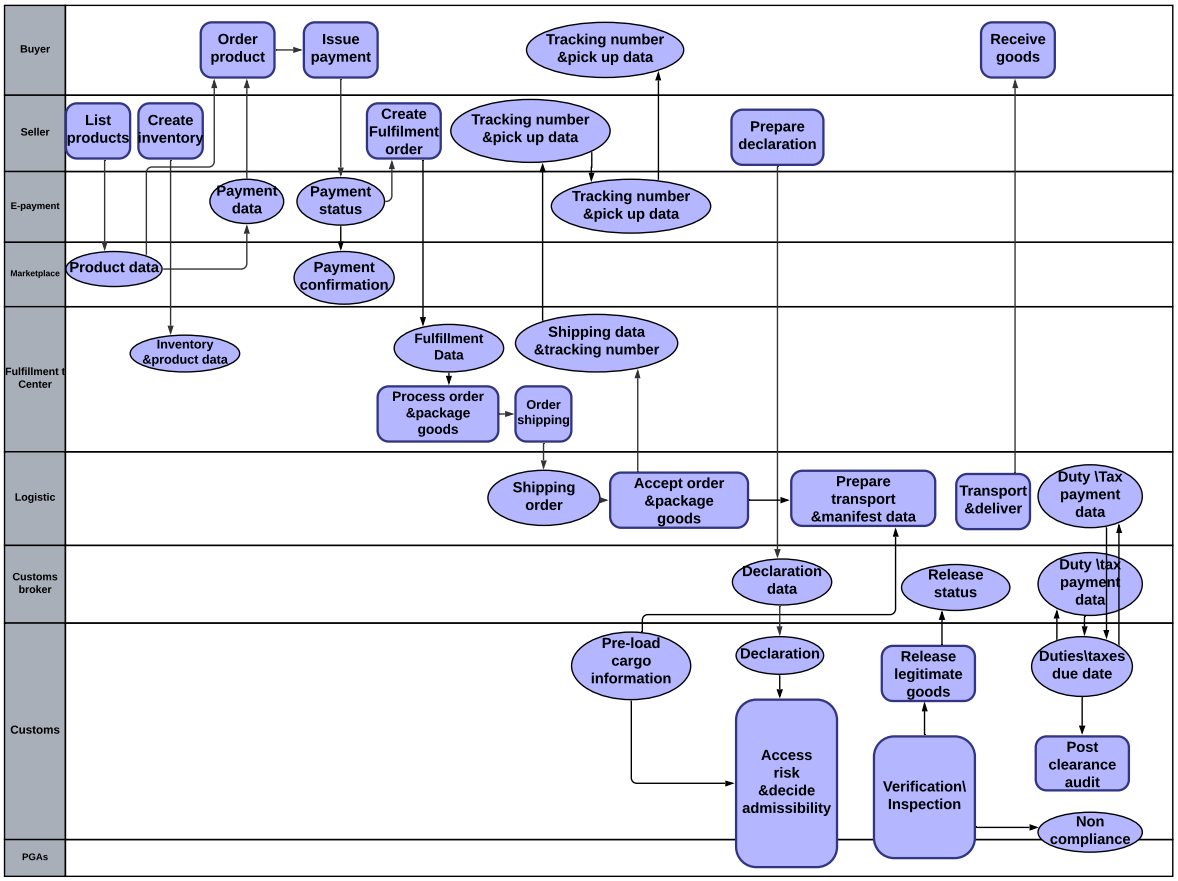


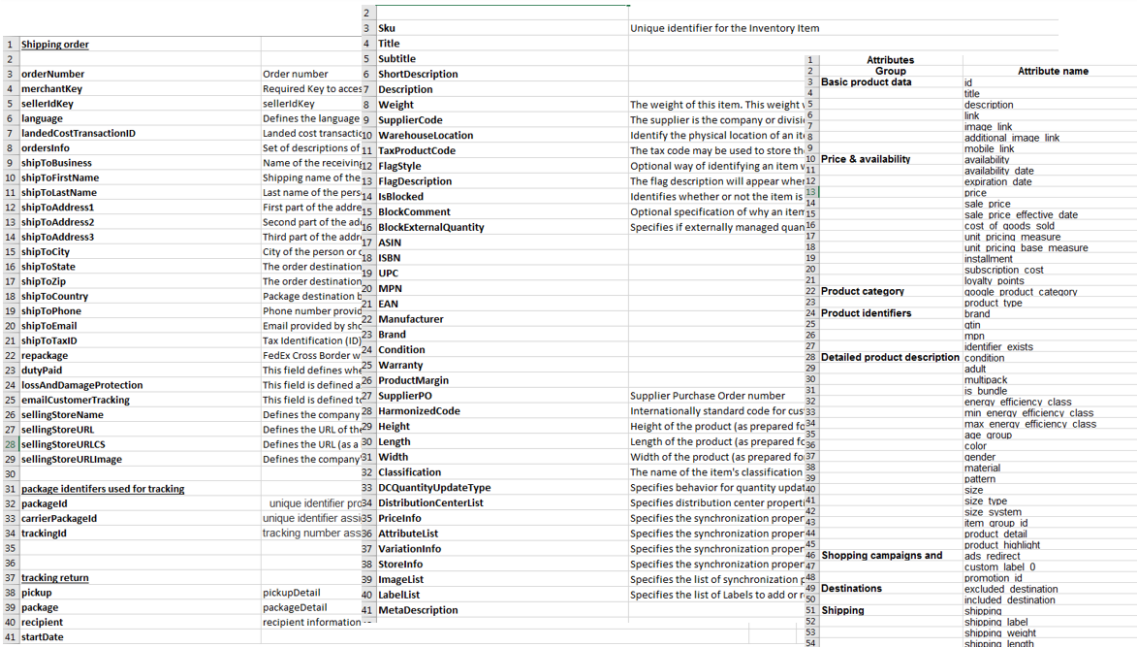
Figure 4.1: Extending WCO e-commerce data flow model. WCO model has only five stakeholder rows without seller, fulfillment, broker.

Fig 4.1 is a process diagram that shows activities of e-commerce stakeholders and intermediaries in e-commerce transactions. The process diagram is developed by extending a baseline model of WCO e-commerce process [59]. Boxes in the figure represent stakeholder activities and elliptic circles represent data exchanged between the stakeholders.

4.4. Data items

The project team conducted a comprehensive survey of data elements exchanged between e-commerce stakeholders. The team collected reference data such as service API specifications, electronic data communication protocols, and data requirements from selected

express carriers, e-commerce marketplaces/platforms, fulfillment service providers, logistics service providers and service aggregators, etc. The collected data is categorized and grouped. Fig 4.2 depicts the data elements.



Shipping order	
orderNumber	Order number
merchantKey	Required Key to acces
sellerIdKey	sellerIdKey
language	Defines the language
landedCostTransactionID	Landed cost transactio
ordersInfo	Set of descriptions of
shipToBusiness	Name of the receiving
shipToFirstName	Shipping name of the
shipToLastName	Last name of the pers
shipToAddress1	First part of the addre
shipToAddress2	Second part of the ad
shipToAddress3	Third part of the addr
shipToCity	City of the person or
shipToState	The order destination
shipToZip	The order destination
shipToCountry	Package destination b
shipToPhone	Phone number provid
shipToEmail	Email provided by sh
shipToTaxID	Tax Identification (ID)
repackage	FedEx Cross Border w
dutyPaid	This field defines wh
lossAndDamageProtection	This field is defined a
emailCustomerTracking	This field is defined t
sellingStoreName	Defines the company
sellingStoreURL	Defines the URL of the
sellingStoreURLCS	Defines the URL (as a
sellingStoreURLImage	Defines the company
package identifers used for tracking	
packageId	unique identifier pro
carrierPackageId	unique identifier assi
trackingId	tracking number ass
tracking return	
pickup	pickupDetail
package	packageDetail
recipient	recipient information
startDate	

Sku	Unique identifier for the Inventory Item
Title	
Subtitle	
ShortDescription	
Description	
Weight	The weight of this item. This weight
SupplierCode	The supplier is the company or divisi
WarehouseLocation	Identify the physical location of an it
TaxProductCode	The tax code may be used to store th
FlagStyle	Optional way of identifying an item v
FlagDescription	The flag description will appear wher
IsBlocked	Identifies whether or not the item is
BlockComment	Optional specification of why an iten
BlockExternalQuantity	Specifies if externally managed quan
ASIN	
ISBN	
UPC	
MPN	
EAN	
Manufacturer	
Brand	
Condition	
Warranty	
ProductMargin	
SupplierPO	Supplier Purchase Order number
HarmonizedCode	Internationally standard code for cus
Height	Height of the product (as prepared fo
Length	Length of the product (as prepared fo
Width	Width of the product (as prepared fo
Classification	The name of the item's classification
DCQuantityUpdateType	Specifies behavior for quantity updat
DistributionCenterList	Specifies distribution center properti
PriceInfo	Specifies the synchronization proper
AttributeList	Specifies the synchronization proper
VariationInfo	Specifies the synchronization proper
StoreInfo	Specifies the synchronization proper
ImageList	Specifies the list of synchronization f
LabelList	Specifies the list of Labels to add or r
MetaDescription	

Attributes Group	Attribute name
Basic product data	id
	title
	description
	link
	image_link
	additional_image_link
	mobile_link
Price & availability	availability
	availability_date
	expiration_date
	price
	sale_price
	sale_price_effective_date
	cost_of_goods_sold
	unit_pricing_measure
	unit_pricing_base_measure
	installment
	subscription_cost
	loyalty_points
Product category	google_product_category
	product_type
Product identifiers	brand
	gtin
	mpn
	identifier_exists
Detailed product description	condition
	adult
	multipack
	is_bundle
	energy_efficiency_class
	min_energy_efficiency_class
	max_energy_efficiency_class
	age_group
	color
	gender
	material
	pattern
	size
	size_type
	size_system
	item_group_id
	product_detail
	product_highlight
Shopping campaigns and	ads_redirect
	custom_label_0
	promotion_id
Destinations	excluded_destination
	included_destination
Shipping	shipping
	shipping_label
	shipping_weight
	shipping_length

Figure 4.2: Sample data items used by e-commerce intermediaries.

In addition, the team has worked together to identify data of interest to the Customs authorities and partner agencies, and determine who should have access. Fig 4.2 summarizes the results.

Certain data items are formally defined by WCO. As a reference, they are listed in Appendix C.

4.5. Certain trends

In order to gain competitive edge in online sales, e-commerce sellers increasingly rely on automation and third party services to manage product listing across multiple platforms, conduct online advertising, automate fulfillment process, select logistics services and shipping methods, optimize inventory management, etc. A medium or large online seller may have products listed/advertised on multiple e-commerce platforms/marketplaces/online stores, and have ordered goods shipped from a network of geo-distributed distribution centers - see Fig 4.3.

Economies of scale favors automated and more efficient approaches to manage distribution centers and warehouses. Logistics functions and services are consolidated to achieve higher capacity utilization and effective sharing of resources, which sometimes results in new challenges with Customs authorities. For instance, consolidation of fulfillment centers and warehouses creates a potential problem where inventories from multiple sellers

Table 4.1: E-commerce data items and those who have access to the data.

	Seller	**Buyer**	**Marketplace**	**Customs Broker**	**Carrier**	**Fulfillment**
Product categories,attributes	X		X	X		
Product description and pictures	X		X	X	X (often less detailed)	X (often less detailed)
LPCO	X		X (subset)	X		
HTS classification			Some SPs	X	Supported by SPs	
Price	X		X	X		
URLs	X	X	X	X		
COO	X		X	X		
Marketplace seller identity	X		X			
Seller information (e.g., name, address)	X		X	X		
Marketplace risk information			X	Likely		
Buyer/consumer information (e.g., name, address)		X	X	X		
Tracking number	X	X	X (not always)		X	X
Port of Entry					X	
Carrier risk information					X	
Shipping mode	X	X	X (not always)	X	X	X
Consignee information	X	X	X	X	X	X
AEO information including certificates	X			X		
IPR licensing information	X			X		
Lab testing results	X			X		
PGA data	X			X		

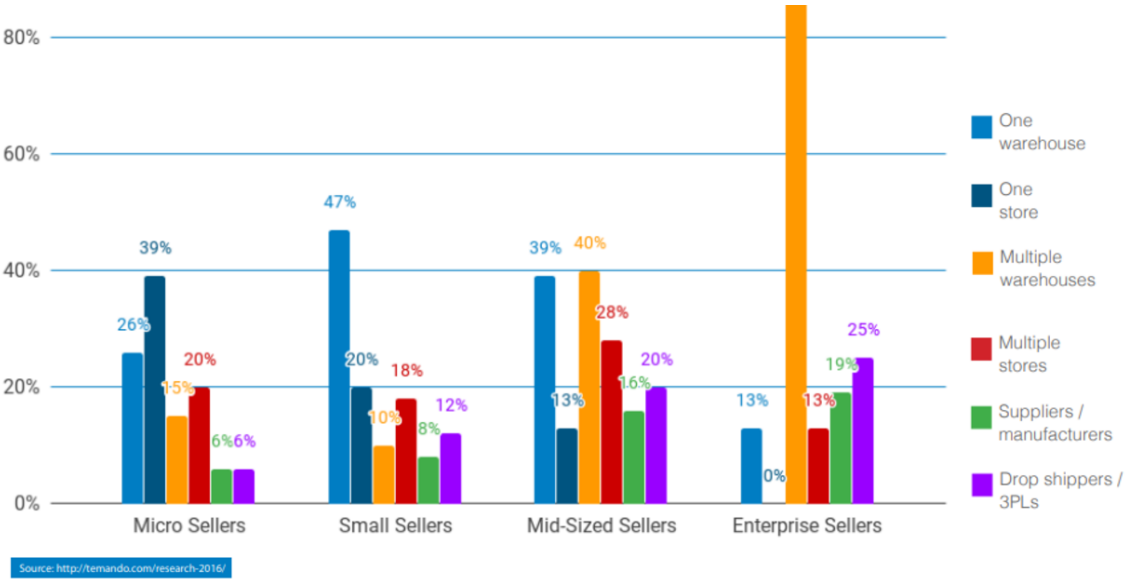


Figure 4.3: Complexity of fulfillment. Sellers apply variety approaches to order fulfillment, source: E-fulfillment research report [46].

could be mingled together, adding to the ever increasing complexity of e-commerce logistics [11, 32].

The complex and dynamic nature of e-commerce transactions, involving many stakeholders and short term relationships between e-commerce sellers and buyers, tends to drive the industry to adopt existing applicable standards, or develops new standards if needed. In particular, logistics service providers, fulfillment centers, and online platforms opt to adopt standards based identifiers and tracking numbers to manage products, inventory, and shipping, which makes data flow within e-commerce more efficient [61].

4.6. E-commerce data challenges

There are specific gaps and challenges for the Customs authorities to obtain complete and accurate data of cross-border e-commerce shipments. These challenges include:

Data held by intermediaries: Certain data elements related to e-commerce transactions, that may be useful to determine compliance and import risks, are held by online platforms, payment service providers, fulfillment network, and other intermediaries. There are practical challenges to obtain data from e-commerce intermediaries. E-commerce intermediaries such as platforms/marketplaces are not traditional filers to the Customs for clearance. Challenges may also arise depending on where, by whom and how e-commerce data is held, which often depends on e-commerce business models.

Seller/intermediary without physical presence: In cross-border e-commerce, goods can be ordered online from a foreign third party seller or a marketplace operated by an entity

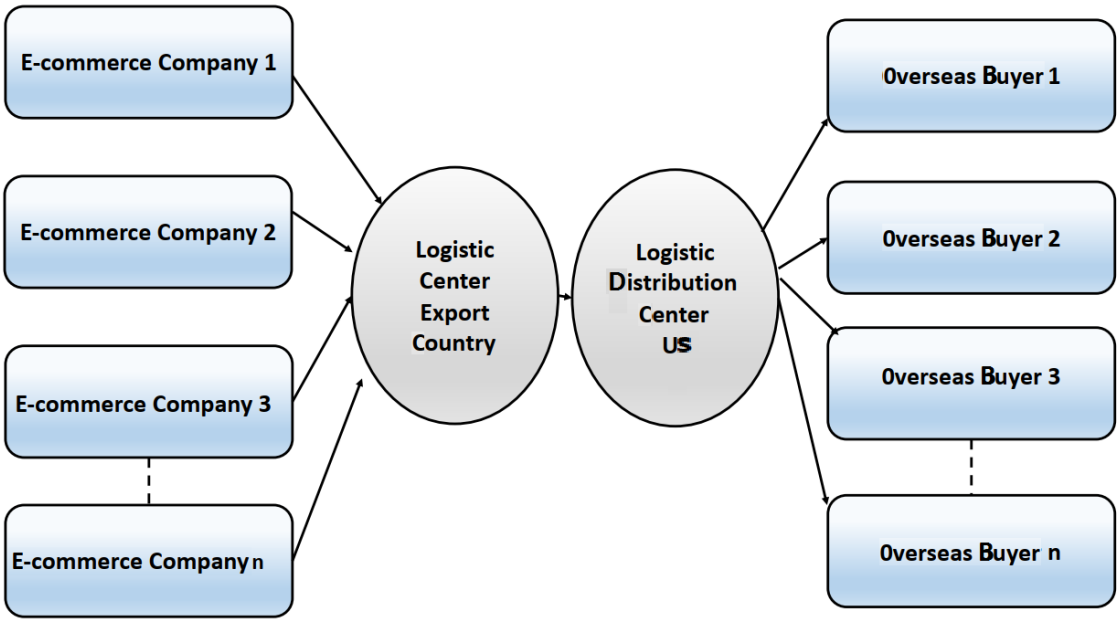


Figure 4.4: Cross-border e-commerce logistics.

in another country. It is not necessary that the seller or marketplace has physical presence in the U.S., which adds further complexity to collect data from the seller or marketplace.

Fragmented data: Data fragmentation is another challenge. Cross-border e-commerce data flows involve multiple stakeholders and intermediaries. It cannot be assumed that a single entity has all the information regarding a transaction. Depending on e-commerce business model and logistics strategies, data items regarding a transaction may be held by multiple entities whereas a single entity may have access to only partial set of data items. Such fragmentation could be exploited by bad actors to engage in fraudulent activity . For instance, “brushing scams” were likely in use during the recent series of unsolicited and unexplained deliveries of seed packets to received unsolicited seed packets . In this case, a fake buyer would purchase merchandise with a gift card (no identifying information), and have mismatched goods (seed) sent to a random person. In a “brushing scam”, marketplaces have no information regarding the items that were actually shipped. Another example is hidden link used to sell counterfeit products in social commerce platforms. In this case, perpetrators run a scheme that involves posting side-by-side photos of a generic, non-branded products that have no issue with Amazon IP protection, and a counterfeit. The text on the posting would read “order this/get this”. The “order this” link points to the non-branded product advertised on Amazon. The “get this” photo refers to the counterfeit products that the buyer would receive.

Low data quality: Both accuracy and quality of data related to cross-border e-commerce transactions are poor. The situation becomes worse when the Trade Facilitation and Trade Enforcement Act of 2015 increased the de minimis threshold from $200 to $800. According to studies and feedback from authority, this change allowed a greater proportion of parcels

and packages entering the U.S. to arrive with less detailed information about what are inside the parcels or packages.

All above result in poor visibility by the Customs authorities to cross-border e-commerce sellers, transactions, and shipments.

The complexity of cross-border e-commerce further increases with the constantly evolving e-commerce business models [1, 4] and adoption of sophisticated logistics strategies. E-commerce business models have grown in complexity, moving beyond simple taxonomy such as B2B, C2C, and B2C. New models have emerged to take advantage of both global digital supply chains and deep integration with the e-commerce eco-system.

5

E-commerce data sharing and standards

5.1. Intermediary responsibilities and liabilities

Under current law enforcement and regulatory practices, e-commerce intermediaries are exposed to relatively little risk of criminal prosecution and/or civil liability. There are ongoing efforts to define responsibilities of intermediaries in cross-border e-commerce, specifically, who within an e-commerce transaction should be responsible and legally liable for illicit or harmful merchandises that cover counterfeit products, dangerous goods, products violating consumer safety, tariff, and import security laws.

Responsibility and liability. In a case that counterfeit products are sold using services provided by online marketplaces and logistics service providers, even by third- party sellers, there should be clear definitions of each involved party's responsibilities. It is expected that e-commerce intermediaries work with the IPR holders to take actions to end the infringing activities when they are notified about violations [5]. In this regard, e-commerce intermediaries have implemented in-house approaches to take more proactive screening of product listing with potentially IP-infringing issues, and respond to the IPR holders' requests to take down the IP infringing listing [6]. The practices vary from intermediary to intermediary [63]. For instance, Amazon implemented a service called, Brand Registry, to help the IPR holders to protect their brands. In addition, Amazon has developed Project Zero. A tool that combines Machine Learning (ML) and other technologies to assist brand owners to detect and remove counterfeits of their products (automated protections, self-service counterfeit removals and product serialization). Alibaba implemented a service, called Alibaba Original Design Protection. It applies, Machine Learning (ML) and image recognition, as well as cloud based infrastructure, to protect and certify product images. Alibaba claims that 96% of takedown requests are processed within 24 hours (business days) and 96% of infringing lists are removed before a single sale .

Conditions and applicability of "safe harbor" immunity. Protections of "safe harbor" for intermediaries from liability may vary among jurisdictions. It often requires intermediaries

to meet certain technical requirements concerning their involvement in transactions of illicit merchandise and counterfeit products, and to have implemented clear policies and terms of services that prohibit illegal activity, and to act upon notices when illegal activity has been discovered. Intermediaries that fail to meet these conditions may not be protected under "safe harbor".

False Claim Act (FCA) and its applicability to cross-border e-commerce. The FCA might be another legal tool for the Customs authorities to address frauds involved in cross-border e-commerce [18]. The FCA punishes any person who knowingly submits a false claim, or causes another to submit a false claim to the U.S. Government, or knowingly makes, uses, or causes to be made or used, a false record or statement material to a false claim, or is part of a conspiracy to commit such acts. The FCA was amended in 2009 to broaden its scope in reverse actions. Since the amendments, FCA claims in the international trade area have increased, in cases of evasion of both normal customs duties and those duties imposed as a result of trade remedy proceedings.

Regulatory efforts. There are ongoing regulatory efforts in both U.S. and EU to hold e-commerce intermediaries more liable for illicit transactions or activities that occur on their platforms. For instance, proposed regulatory changes would require e-commerce platforms to take proactive measures to prevent selling of illicit, harmful or IP infringing merchandise to consumers. Intermediaries that fail to take these steps can be held liable for the consequences.

Deemed supplier for Customs process: In EU, starting 2021, online marketplaces may become the deemed suppliers when they facilitate certain cross-border B2C transactions of their third-party sellers. If a marketplace is considered to meet the condition of facilitating a sale, it will be liable to collect, report and remit the VAT due from the consumer. It is worth mentioning that the rule applies only to VAT and does not extend liability to the products.

Regulatory efforts may have huge impacts on cross-border e-commerce intermediaries and their practices. The landscape constantly evolves. It seems that intermediaries are under pressure from the legal and regulatory aspects, to take proactive and effective measures to thwart illicit activities on their platforms, and share data regarding high risk cross-border e-commerce transactions with the community stakeholders and the Customs authorities.

5.2. Extended AEO program for e-commerce

One approach to incentivize voluntary compliance and data sharing with the Customs authorities, is to develop a new AEO program tailored for cross-border e-commerce environment. The need to extend and customize the existing doctrine of AEO to include e-commerce intermediaries and stakeholders is well recognized. A comprehensive AEO program for e-commerce may pave the road leading to potentially transformative changes to sharing of cross-border e-commerce data by various intermediaries with the Customs and other regulatory agencies.

5.2.1. Background

The current Authorized Economic Operator (AEO) doctrine, based on the WCO recommendations and AEO framework, was mainly developed before the era of e-commerce [42, 54]. It was not originally designed for the e-commerce environment. Neither does it take into account unique aspects of cross-border e-commerce such as diverse cross-border e-commerce business models and complex e-commerce logistics landscapes. Based on principles of the original AEO framework laid down by the WCO, there are opportunities to develop an e-commerce focused AEO program that establishes and nurtures partnership between the Customs authorities and e-commerce stakeholders for adopting higher standards of e-commerce functions including data sharing.

Working with the e-commerce stakeholders, guidelines and best practices can be developed [38]. The program can grant beneficial customs status to the voluntary e-commerce intermediaries and online sellers that adhere to the guidelines and best practice requirements. These guidelines may focus on, proven and known effective practices by various e-commerce intermediaries or sellers to prevent illicit and harmful merchandise from entering into the U.S. through cross-border e-commerce supply chains. Specific themes of e-commerce AEO program could include:

- E-commerce AEO covering as broad intermediaries and stakeholders as possible (e.g., marketplaces, fulfillment centers, e-commerce logistics service providers, online sellers, payment service providers)
- Leveraging emerging technologies to enhance implementation of AEO program
- Plurilateral e-commerce AEO initiatives such as commonly accepted global standards, mutual recognition, etc.
- Leveling playground for MSME and disadvantaged e-commerce stakeholders

5.2.2. Principles

Framework of e-commerce AEOs could adopt common principles of AEO programs such as:

- Sharing electronic information regarding cross-border e-commerce transactions and shipping (e.g., data items pertaining to inbound parcels that link the parcels to e-commerce marketplace, foreign warehouse, online seller, product listing details)
- Upholding to high standards and risk management by e-commerce intermediary such as adoption of best practices and guidelines (e.g., rigorous standards of vetting third party sellers; validating product listing in high risk product categories – meeting safety standards, PGA requirements, mandatory registration of PGA restricted products;

proactive IPR protection program; verifying source of products including COO); validating inventory by fulfillment and distribution centers - know-your-inventory (e.g., origins, IPR licenses, product safety, LPCO requirements)

- Customs and business partnership where CBP will provide benefits to the intermediaries and sellers that meet cross-border e-commerce standards, guidelines, and best practices
- Flexibility of the best practice guidelines tailored for the diverse business models and practices of e-commerce stakeholders (e.g., separate best practice guidelines for marketplaces, fulfillment centers, and online sellers; flexibility considering scale and size of intermediaries to ensure that such program will not put MSMEs at disadvantage positions comparing with large intermediaries or online sellers with more resources to be certified as AEOs)

To put things in perspective, CBP has already developed best practice recommendations for intermediaries regarding IPR protection and counterfeit products. The efforts can be extended beyond IPR protection, and cover broad Section 321 e-commerce transactions.

To receive AEO certification as trusted intermediaries or trusted online sellers, e-commerce AEO applicants could:

- Demonstrate compliance with the Customs requirements regarding best practice guidelines
- Maintain data sharing programs with the Customs and take measures to ensure data quality and accuracy
- Cooperate with other e-commerce intermediaries and stakeholders to enable data sharing within the e-commerce stakeholder community to improve security and safety of global supply chain, and facilitate adoption of open standards
- Adopt internal process to measure and analyze effectiveness of best practices, and develop enhancement based on evidence

5.2.3. Benefits

Customs and the PGAs could provide benefits to the trusted e-commerce intermediaries and sellers. These benefits could include:

- Expedited processing and clearance
- Reduced examinations
- Less targeting due to low perceived risk associated with such transactions

- Access to information of value to AEOs
- Penalty mitigation
- Predictability of e-commerce transactions and shipping

E-commerce intermediaries can receive other direct and indirect benefits to participate in AEO program including:

- Perceived low risk by customers, which could potentially have positive impact on online sales
- Increased certainty in cross-border delivery (less risk of denied entry by the Customs and PGAs)
- Improved reputation among customers

Accredited marketplaces or sellers could advertise their AEO status to the customers.

5.2.4. Data Sharing

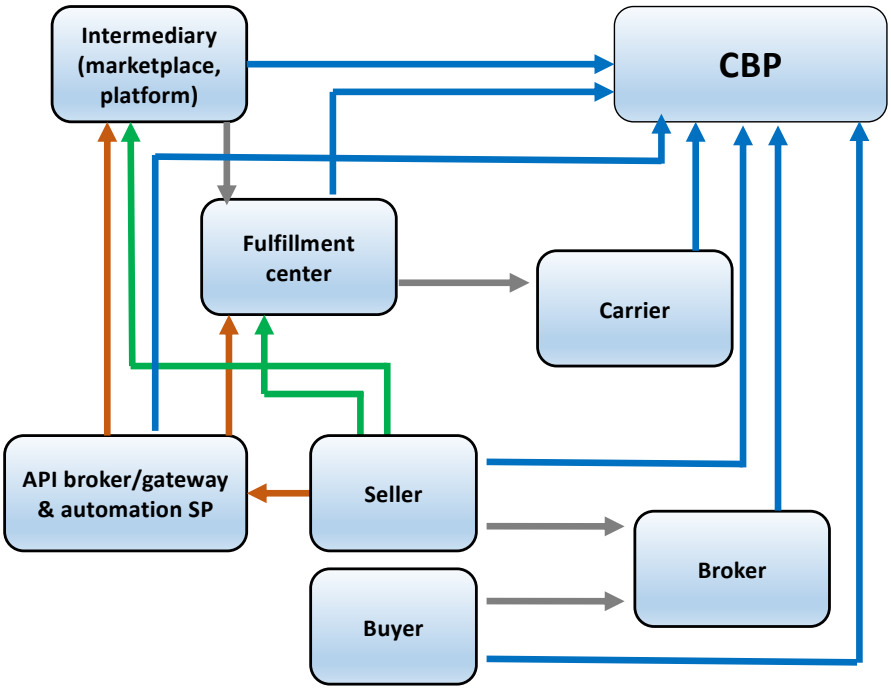


Figure 5.1: Data sharing between CBP and e-commerce stakeholders.

Table 5.1: Data sharing activities.

Expand B2B data sharing between e-commerce stakeholders	– Intermediaries (marketplace, fulfillment center) share additional data during B2B transactions (e.g., support associating e-commerce shipment tracking number with marketplace, marketplace seller identity, product listing, fulfillment inventory identity).
Trusted intermediary program	– Develop standards, unified risk measurement, best practice, guidelines. – Establish data sharing agreement between intermediary and CBP. – Align intermediary internal practice with the standards/recommended guidelines and best practice regarding IPR protection, product safety, etc (know-your-seller, know-your-inventory). – Share implementation and performance data with CBP. – Evaluate effectiveness of intermediary implementation. – Rate compliance level by CBP.
Data sharing between e-commerce intermediary and CBP (transaction level data)	– Register intermediary. – Share necessary data to link e-commerce shipment with marketplace, seller identity and seller information, product listing data.
Trusted seller/vendor program	– Register seller/vendor. – Share product listing data, update product listing data. – Adopt best practice (know-your-supplier, IPR safeguard). – Rate seller/vendor compliance level by CBP.

Extending AEO to e-commerce intermediaries could alleviate current data gaps regarding cross-border e-commerce transactions. Data can be shared at different granularity levels and over varying periods of time. For instance, a marketplace can share a complete list of sellers with U.S. customers, and products that have been sold or shipped to the U.S. consumers. The data items could include, detailed seller information (obtained through vetting process), product listing data such as descriptions/specifications, product photos, price, supplementary documents (e.g., FDA registration, lab test results, certificates of COO).

At the per transaction level, for each product sold to U.S. consumer,the marketplace can share seller information including URL to seller's store, product listing data, and tracking number with Customs authorities. At minimal compliance level, marketplaces could share e-commerce transaction data for product categories with high risk. A potential challenge regarding implementation is that marketplaces and platforms often have developed their own unique approaches to categorizing products. The diverse product taxonomy systems make it difficult to realize targeted data sharing based on product categories with uniformity and consistency across e-commerce intermediaries.

Table 5.2: Data items and granularity of sharing

	Overall data sharing	**Per e-commerce transaction level**
Intermediaries (marketplaces, fulfillment centers) with Customs authorities	Due diligence – Seller vetting process (know-your-seller) – IPR protection (e.g., take-down notice, data sharing with IPR owners, AI based analytics) – PGA requirements (restricted product categories) – COO – LPCO validation – Know-your-inventory (distribution center, fulfillment center) Data sharing – Performance results	For each transaction – Product Information – Product listing data – Price information – Seller identity and data – Risk information – Tracking data of shipment
Seller with Customs authorities	Data sharing in advance – Product listing data – Product information – Classification – Price information (estimate) – COO – PGA data – IPR licenses	For each transaction – Seller registration data – Product registration data – Other required declaration data

With additional data items from the intermediaries, Customs authorities can connect cross-border e-commerce shipping data with e-commerce data such as marketplace, product listing, inventory data at distribution center, etc., as illustrated in Fig 5.2. Availability of additional data items could improve targeting capability.

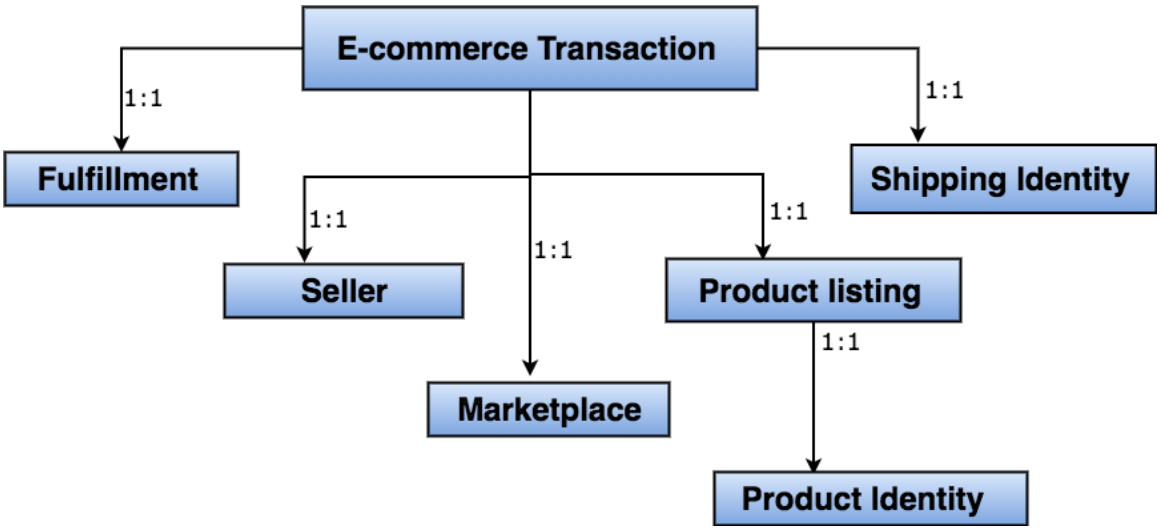


Figure 5.2: Linking e-commerce data.

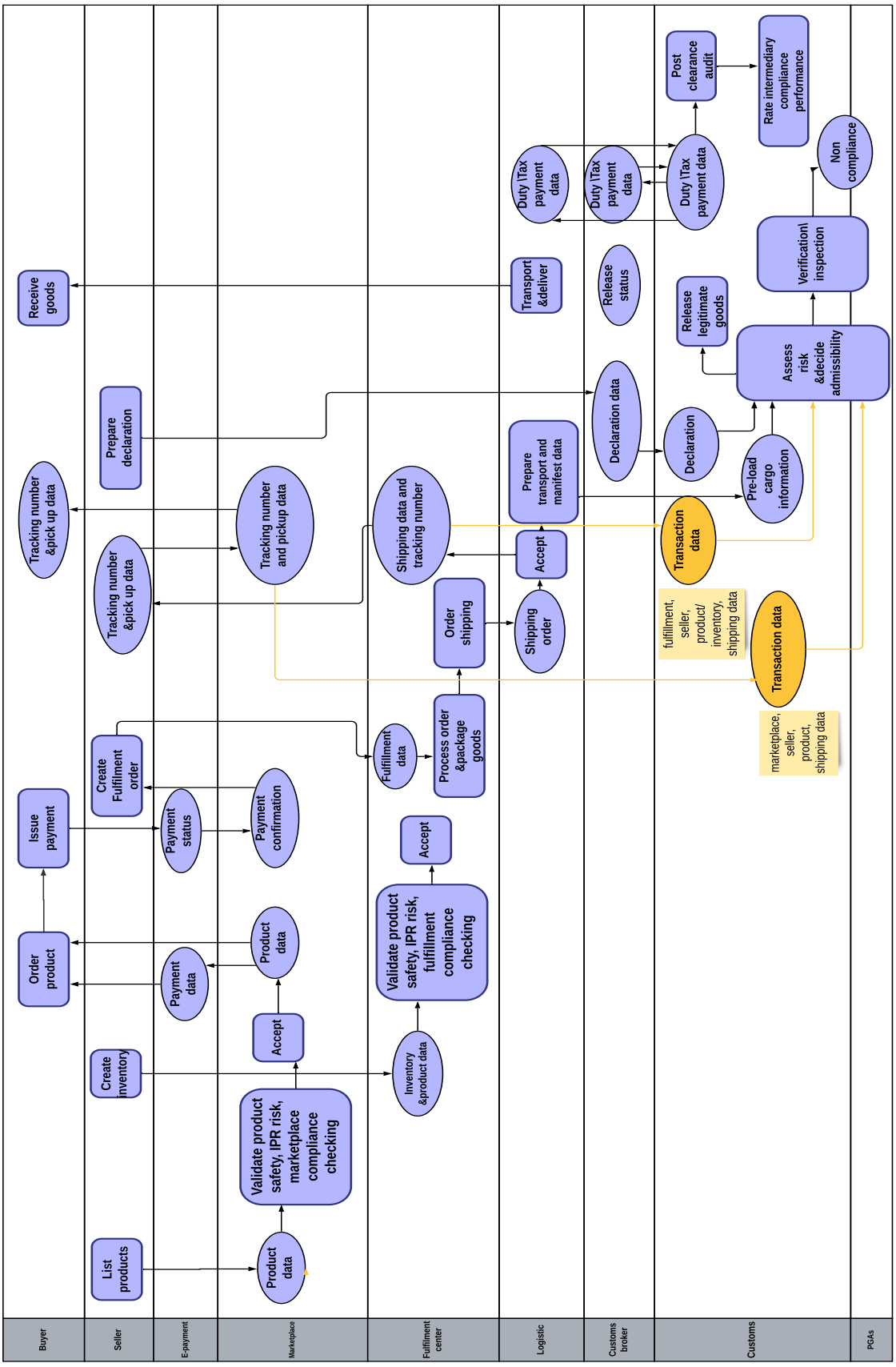


Figure 5.3: Process diagram illustrating that intermediaries share data of e-commerce transaction with the Customs authorities and partner agencies. Boxes in the figure represent stakeholder activities and elliptic circles represent data exchanged between stakeholders.

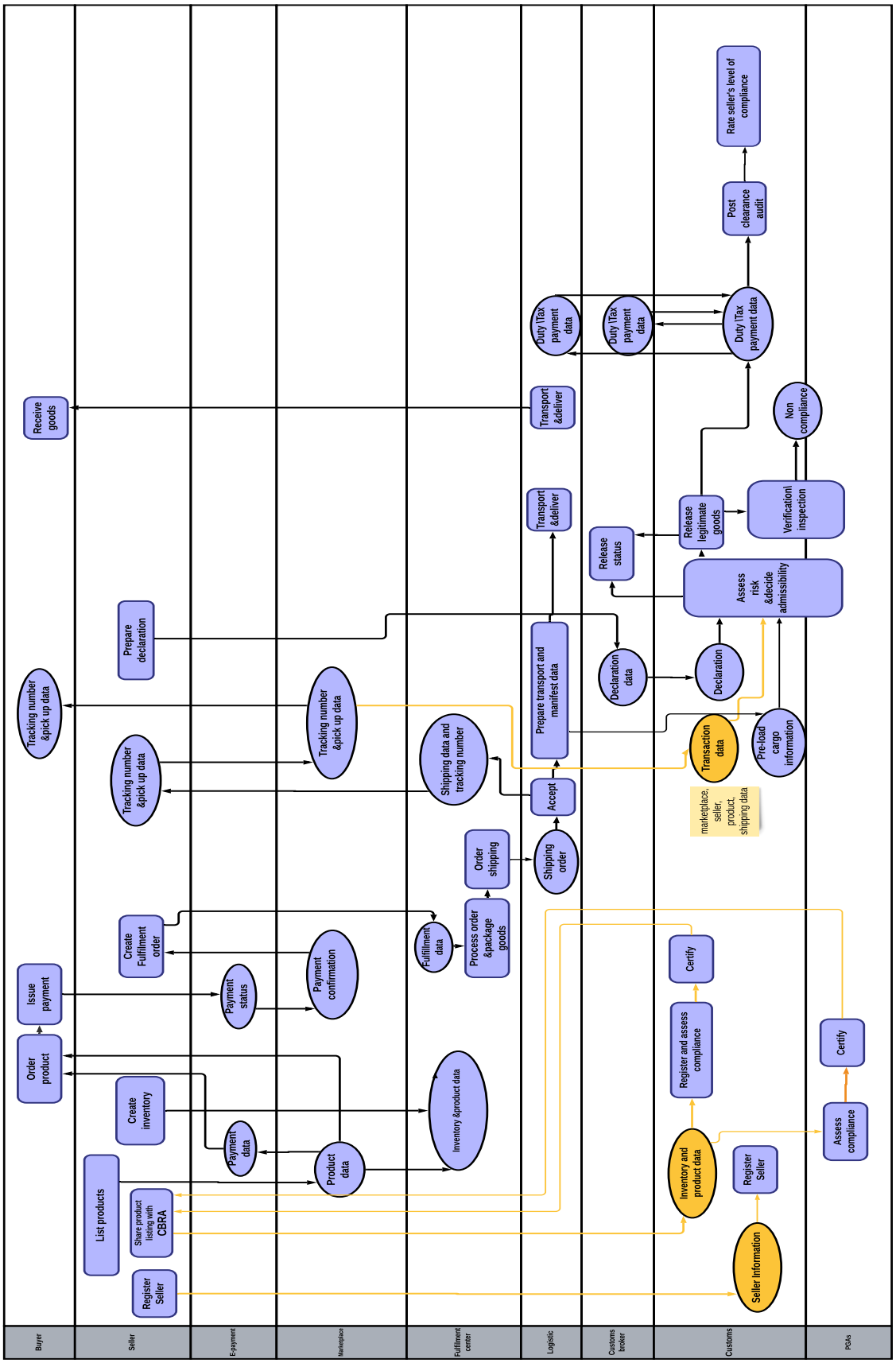


Figure 5.4: Process diagram illustrating that intermediaries including fulfillment centers and sellers share e-commerce data with the Customs authorities and partner agencies. Boxes in the figure represent stakeholder activities and elliptic circles represent data exchanged between stakeholders.

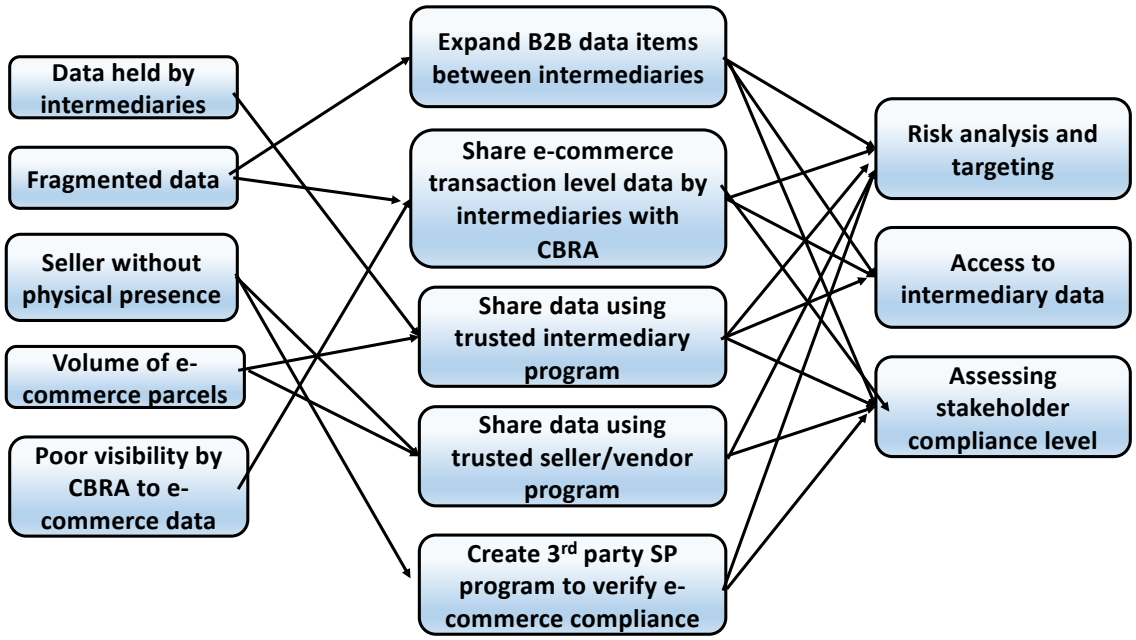


Figure 5.5: Data sharing and impacts to e-commerce data gaps.

5.2.5. Issues to be considered

Customs authorities and private sector stakeholders can work in tandem to create a data sharing environment that could bring benefits in terms of improving both trade facilitation and import security in the long run. Figure 5.6 shows a high level process diagram of interactions among the stakeholders including efforts to develop and adopt guidelines and best practices for data sharing.

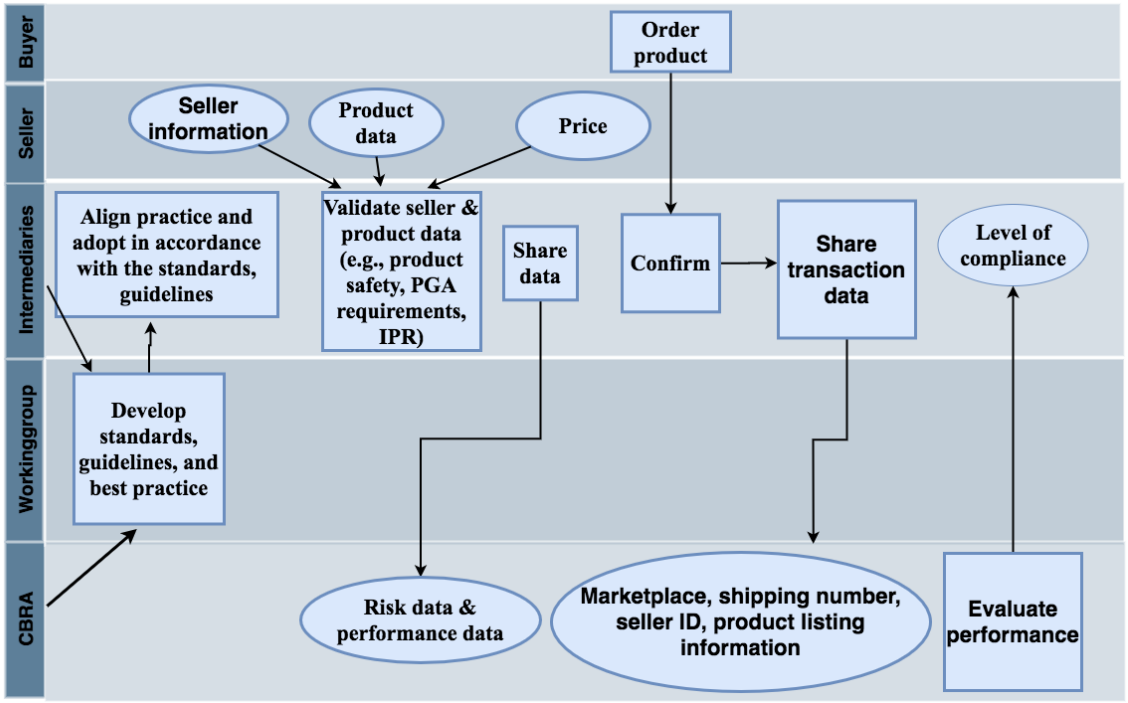


Figure 5.6: Data sharing process. Boxes in the figure represent stakeholder activities and elliptic circles represent data exchanged between stakeholders.

It is sometimes misunderstood that the AEO instruments only benefit large entities and intermediaries with resources to implement various AEO requirements. Large e-commerce platforms and intermediaries with a multi-country presence often have financial resources, ICT infrastructure, and human resources to invest on proactive measures to vet third party sellers, validate product listing (particular product categories with high risk), experiment with new technologies on data sharing with authorities, and apply AI and data mining to detect illicit activities and prevent bad actors from using their platforms to sell harmful or counterfeit products.

E-commerce environment is made of numerous MSMEs.(Micro, Small and Medium Size Enterprises) There are an estimated 12 million – 24 million e-commerce sites across the entire globe. Amazon reports that its platform has over 1 million U.S. MSME sellers. On Etsy's SME e-commerce platform(Small and medium-size enterprises), over one-third of sales are international. An e-commerce oriented AEO program should make it easy for small and medium-sized enterprises to participate and go through the validation process. In this regard, AEO program should take into account the challenges that MSMEs are facing.

For instance, a legitimate concern is that large e-commerce intermediaries or sellers may have advantages over MSMEs to implement and adopt AEO requirements and standards as they already have invested in related programs and technologies. The additional benefits from gaining AEO status by the large intermediaries could have significant impacts and consequences for smaller stakeholders in the e-commerce environment. This challenge could be addressed if AEO program is designed from the beginning with the situations and

needs of MSMEs being taken into account. A set of one-size-fits-all best practice guidelines for all the e-commerce stakeholders regarding factors such as product sector, scale, volume and business model, most likely does not exist. A multi-tiered AEO program with different AEO rating and accreditation levels may be one approach where intermediaries and sellers can choose the amount of effort and resources that they opt to invest suitable to their situations on implementing best practice guidelines and data sharing requirements. Another consideration is to leverage emerging technologies to level the playing field and reduce cost to be compliant (subject of chapter 6).

Cross-border e-commerce is conducted over the Internet and the global web and is therefore international. An e-commerce AEO program should extend to the intermediaries and/or online sellers that have no physical presence in the U.S. but have U.S. customers. These include, platforms or marketplaces operated by foreign entities, foreign warehouses and distribution centers, and oversea sellers who use e-commerce to sell merchandise to the U.S. consumers. Plurilateral collaborations or agreements are likely important aspects of e-commerce AEO program.

To highlight some of the challenges, many countries enforce some forms of localization laws to restrict data flows across borders.Over 120 countries have regulations related to data protection, often requiring data localization. Regulations limiting cross-border data flows and requiring local storage are localization requirements that prohibit companies from exporting or sharing data outside a country [2, 17].

Such restrictions can pose significant barriers to any data sharing program for e-commerce. A key issue is how data sharing in an e-commerce oriented AEO program can overcome such a challenge and balance unrestricted data flows, localization protection, other relevant country specific cyber-security and privacy regulations.

To summarize, a set of policy considerations as potential force multipliers to enhance data sharing and reduce barriers may include :

- Create private – public partnership to develop data sharing guidelines
- Identify in advance what type of information can be expected from intermediaries to be shared
- Recognize that data sharing may differ depending on intermediary's or seller's business model (e.g., kind of information available for sharing, when the information is available) and economic scale
- Provide clear guidance on type of information considered relevant, and ensure that the collected data will be used to improve efficiency and increase compliance
- Consider measures to facilitate compliance
- Develop approaches to avoid same information from being submitted multiple times.

- Maximize use of the collected data for improving efficiency (e.g., correlating with other data sources)
- Work with intermediaries and e-commerce stakeholders to identify data sharing strategies that can achieve balance between data sharing obligations and burdens on intermediaries to be compliant
- Provide tiered data sharing model and options that allow intermediaries and/or sellers to choose a data sharing implementation appropriate for them (e.g., type of e-commerce business, scale of business)

5.2.6. Impacts

Any proposed AEO and/or data sharing programs extending to e-commerce environment will have impacts on the stakeholders. Table 5.3 provides a high level analysis how some of the main stakeholders may be affected.

Table 5.3: Impacts to e-commerce stakeholders.

Intermediaries	Cooperative intermediary will implement data sharing protocols. Additional cost may incur for due diligence to be compliant (e.g., vetting sellers for PGA data requirements, adopting know-your-inventory practice by warehouses to check safety, IPR licenses, required registrations, etc). Cooperative intermediary will expect cost to maintain data sharing with CBP using ACE. Intermediary will receive rating or certification of compliance level/good standing status from CBP and PGAs. Cooperative intermediary may boost its reputation to U.S. consumers by participating in data sharing program. Buyers may benefit from expedited customs clearance process.
Sellers	Low risk sellers/vendors may expect sharing additional data with cooperative intermediaries. Cooperative sellers may choose to share product listing data with CBP using ACE. The process can be automated using 3rd party services or tools. Cooperative sellers will benefit from the program by increasing reputation and trustworthiness among consumers. Seller can reduce compliance cost through 3rd party service providers (verify compliance once and share with multiple intermediaries).
Consumers/ buyers	U.S. buyers will gain access to additional data to be informed about risks purchasing on certain marketplaces or from certain sellers. Buyers will be positively impacted by the higher standards of product listing and vetting process. There will be no privacy concerns as result of data sharing program. Buyers are not affected when purchasing goods online.
Customs brokers	Customs brokers will need training to help customers to share data with CBP. Customers may include, e-commerce intermediaries and/or e-commerce sellers/vendors. Data sharing will be automated using electronic data transfer protocols. Brokers will likely pay subscription fees to service providers who implement data sharing protocols.
CBRA	CBRA will receive additional data from the cooperative e-commerce intermediaries, cooperative sellers/vendors at both e-commerce transaction level and/or aggregated data record level (quarterly, annually for CBRA to determine effectiveness of intermediary's efforts and in-house compliance programs). CBRA will need additional tools to receive, process, store, and analyze data shared from the e-commerce stakeholders. These also include integrating new data items/attributes with risk based targeting system, monitoring key indicators to assess effectiveness of data sharing, measuring stakeholder compliance level, etc.
MSMEs	MSMEs may be affected. After initial cost to implement data sharing, with high chance, MSMEs might be positively affected (e.g., reputation, certainty, supply chain predictability, leveling play field by removing bad actors). Cost might be a concern for some MSMEs (e.g., having product listing validated or certified). Some MSMEs may decide to switch to non-cooperative intermediaries, and be negatively impacted. Intermediaries may take steps to reduce impacts to MSMEs by focusing on only high risk sellers and PGA controlled product categories. Compliance cost to MSMEs could be reduced by adopting new technologies.

Further potential impacts to e-commerce AEO and/or data sharing programs to economic and customs functions include projections of likely consequences on enforcement, targeting, stakeholder competition, overall impact to importation, compliance cost, etc., Table 5.4 provides a summary of the analysis.

Table 5.4: Impacts to Customs' and business functions.

Impact to risk based targeting	Shrinking haystack, additional data to CBRA for assessing risk.
Impact to fraud level	Fraudsters may switch to services of non-operative intermediaries. Fraud will likely decline at large intermediaries. Impact to overall fraud level is uncertain.
Impact to competition	Large cooperative sellers and intermediaries may have advantages due to enhanced reputation, faster delivery service, and overall low cost to be compliant (ICT, access to expertise and talents, operational cost). Technologies may help to level the play ground (see chapter 6).
Impact to e-commerce business models	Anticipated increase in attraction of e-commerce business models where intermediaries do not involve in fulfillment and shipping. The actual impact to seller's logistics strategy is uncertain.
Impact to safety of imported products	Products with safety concerns or not meeting PGA requirements will likely switch to services of non-operative intermediaries. Overall percentage of imported goods with safety issues will decrease because limited popularity of non-cooperative intermediaries among consumers/buyers.

5.3. Leveraging private sector data federation efforts

5.3.1. Background

There have been growing efforts in the private sectors to construct federated data environments for e-commerce that build on top of open and de facto standards. The actual efforts may take a variety of forms. For instance, a community of stakeholders in e-commerce logistics may work together to develop and implement guidelines of a federated data platform that can integrate a range of information and data services to support e-commerce logistics functions and processes. In many cases, public entities or standard making bod-

ies also work with the private sector stakeholders to develop data exchanges standards for cross-border e-commerce. One example is collaboration of Universal Postal Union (UPU) with WCO, ICAO, and IATA to develop and adopt electronic advance data for international parcels.

These efforts may apply different collaboration models with names like, federated data platforms, consortia, alliances, data hubs, etc. In essence, these represent similar industry efforts to forge a community of e-commerce stakeholders, work jointly to develop both standards and guidelines for data exchange and data sharing, and showcase implementation and embodiment to the stakeholders. The communities may comprise stakeholders in a specific vertical or horizontal industry sector. For instance, federated data platforms or solutions could be created around a product sector (e.g., pharmaceutical, consumer electronics, automobile supply chains, apparel & footwear), a group of logistics service providers, a global network of fulfillment/distribution centers, a group of IPR holders, or a set of shippers and carriers. If successful, a federated service infrastructure supported by its participating organizations will be able to provide a set of standardized e-commerce services to its stakeholders, augmenting both business activities of the private sector and governance procedures of the public sector.

5.3.2. Driving forces

Prior to such efforts, development of data and service standards have been dominated by major and large players, which often leads to proprietary solutions with bilateral implementations for many e-commerce stakeholders. Drawbacks of proprietary and non-standard based solutions are well recognized. Cost and efficiency can be major problems as sellers and e-commerce stakeholders have to interface with services of many different providers, thus facing the increasing complexity and cost for managing flows of information exchange.

As e-commerce consumers favor faster delivery and lower cost, intense competition among intermediaries and online sellers drives innovations to make e-commerce processes more consolidated and automated. Successful sellers often have presence on multiple marketplaces and platforms, and have inventory managed by a network of geo-distributed warehouses and distribution centers. Taking advantages of the opportunities, many third party service aggregators offer automation solutions to online sellers so that functions like product listing, order fulfillment, inventory management, and logistics are to be either fully or partially automated using advanced optimization and smart technologies such as AI and big data. Meanwhile, these third party service providers often hide complexity and heterogeneous service interfaces from their customers. In such new competitive environment, the old practice focusing on bilateral collaboration between any two stakeholders or organizations has become an obsolete strategy .

5.3.3. Characteristics of federated data platforms

At high level, federated data platforms may consist of the following components:

- A federated ICT infrastructure instead of a centralized infrastructure controlled and managed by a dominant player in e-commerce
- A network of digital services that creates a community for data exchanges and data sharing to meet the needs of the stakeholders
- Adoption of existing, open and de facto standards for data exchange and data sharing
- Means of piggy backing by the Customs authorities on data exchanged over the federated infrastructure

5.3.4. Design principles of federated systems

A federated infrastructure may consist of a web of data exchange and data sharing services for e-commerce business functions and processes. To facilitate efficient and large scale data sharing, federated infrastructures may apply certain common design principles. These include but not limited to:

- **Decentralized and federated environment:** It consists of platforms that are maintained by different service providers, whereas these platforms can operate independently and provide a range of services to stakeholders (e.g., data storage service, identity management service, data exchange service, data analytics service, data broker service, communication service).
- **Data quality assurance and validation:** It should integrate built-in mechanism to assure data quality and provide service interfaces to the stakeholders and customers to validate data shared or received. Decentralized or federated identity management could contribute positively to data quality assurance. Federated or decentralized identity providers in the system can provide identification of stakeholders and attestation. Identity management could be realized or enhanced with emerging technologies such as Distributed Ledger Technology (DLT) and/or efforts of W3C Decentralized Identities (DID) to support a distributed registry of trusted identity service providers.
- **Flexibility and adaptability:** Services offered by the federated infrastructure should be tailored to the requirements of the stakeholders. The infrastructure should allow stakeholders to customize the service interfaces and adapt to their own business requirements and internal ICT platforms, and still enable the stakeholders to interoperate with one another.
- **Technology independent infrastructure services:** The infrastructure and services should be specified in a technology independent manner, thus enabling different

service providers to offer implementation and embodiment supported by different technologies.

- **Data analytics support:** The service infrastructure should provide analytics capabilities to integrate, aggregate, and analyze data from multiple transactions and/or data flows.

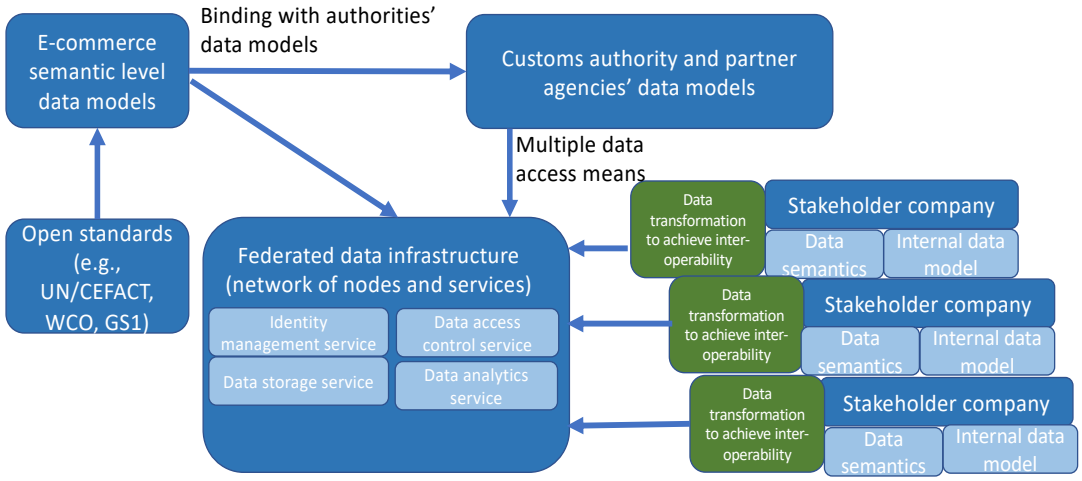


Figure 5.7: Conceptual federated data infrastructure based on open standards.

Fig 5.7 depicts a high level diagram of key components of a federated data environment that reflects the aforementioned principles. The e-commerce data model consists of data items, business processes, and interaction patterns derived from open and de facto standards. The model can be further refined and adapted by the stakeholders and by the Customs authorities. A federated infrastructure comprises a network of services that implement data exchange and data sharing. Interoperability between different federated infrastructures will be discussed next.

The e-commerce data model is preferred to be specified at a semantic level instead of being restricted to a specific syntax such as EDI, XML/XSD, RDF. In actual data communication between two stakeholders, the model could be realized using either EDI, XML or RDF to support flexibility. A stakeholder in the system can formulate its own specific view of the e-commerce data model. An API and service layer can be situated between the federated infrastructure and a stakeholder's internal data model. This layer will enable interoperation between a stakeholder's internal view of the data model and the general data model. It can translate both inbound and outbound data based on standards and facilitate data exchange.

In a federated environment, data can be shared in a variety of ways. A stakeholder in the system can push data to another stakeholder using electronic data messages. Data can be

shared or published in public to other stakeholders within the system (e.g., sharing information of bad actors of e-commerce with other private sector stakeholders and authorities). As an alternative, using service API calls, data could be pulled from a federated infrastructure with unique links or identifiers identifying the data items. Such data sharing infrastructure requires a full-fledged data access management solution. Data access management allows individual data owner and stakeholder to control access to its own data. Data maintained in a federated structure can be categorized into:

- **Shared community data:** Data available to the participants of a federated data sharing environment (e.g., information of infringing sellers or bad actors in a federated IPR data sharing community).
- **E-commerce transaction data:** Data shared between two stakeholders engaged in data exchange pertaining to an e-commerce transaction such as transactions between payment service providers and platforms, transactions between marketplaces and fulfillment centers to fulfill ordering, transactions between fulfillment centers and express carriers.
- **Event data:** Data indicating status or outcome of real-world activities such as products shipped, arrival at destination, etc.
- **Open data:** Data publicly available.
- **Data shared with authorities:** Data accessible to the Customs authorities and partner government agencies. Access to certain data may be made available to the authorities upon requests.
- **Internal data:** Data is only shared within a stakeholder organization, based on the access control rules specified by the stakeholder.
- **Restricted data:** Data restricted from being accessed by certain participants in the system.

Innovative solutions could be employed to enable access control management in a federated data infrastructure (e.g., DLT based data access management).

5.3.5. Data sharing with authorities

Customs authority and partner agencies can receive data from a federated data infrastructure through binding authority data model with the e-commerce data model specified by the data governance body of the federation environment. Customs authority can create its own data requirements (as extension to Single Window). There can be different options by the Customs authority to pull data from a federated data infrastructure. These include but not limited to, sending query to the system using well defined API interface, automatically receiving data pertaining to a transaction after it has been recorded, risk based scan or inspection of data held in a federated data system, etc.

In case there are multiple authorities with data requirements (e.g., PGA data), instead of developing separate data binding for each authority, Customs can take a leading role or agencies can cooperate to create a unified and harmonized data binding model. As a consequence of the binding, Customs authority and partner agencies will gain visibility to e-commerce supply chains.

5.4. Standards and interoperability

Standards play critical roles in facilitating data exchanges in all scenarios including B2B, Business to Government (B2G), and Government to Government (G2G). This section analyzes the current state of the art in e-commerce related standards, in particular from the perspective of data sharing, and interoperability.

5.4.1. Background

To support smooth e-commerce information flows, standardization is important and a crucial element. Various standards have been developed to support different functions of e-commerce such as standards related to product description and classification, tracking, packaging, transportation, safety, monitoring of physical flows of goods. There are general standards (e.g., EDI, XML, RDF) that define basic data formats and paradigms of data exchange and communication. These standards often serve as basic layers in a data management infrastructure or data sharing protocols. On top of these, there are business function specific standards. In many cases, standards are developed for particular business areas (e.g., tracking, postal network, product safety) or industry sectors (e.g., consumer electronics, food). A data sharing infrastructure may also choose appropriate standards depending on how data is collected and exchanged such as push based, pull based, web scraping. Since e-commerce data flows certainly involve a suite of standards, standard interoperability is a major issue in developing data sharing solutions for e-commerce.

Standards can be analyzed with a multi-level approach. A popular methodology is the layered view of standards defined by the European Interoperability Framework (EIF) [14]. According to the EIF, standards can be separated into layers. Two of them are semantic and syntax layers. Syntax layer concerns with formats of data whereas semantic layer focuses on interpretation of data. The semantic layer could be further divided in three different subcategories according to the e-Business Specifications of European Committee for Standardization (CEN) [9].

- **Document definition:** Standards specify document semantics and the metadata. For instance, standards include XML document definition that provides a generic type structure for semantics.
- **Vocabulary:** Standards specify terminology within the structure, the actual labels/names used to specify structural elements. These may include taxonomies, vocabularies, and code list.

- **Identification:** Standards deal with the ability to locate, find, distinguish, link, and reference to objects or instances such as identifiers, GS1 identification keys, tracking numbers. It focuses a scheme or approach for identification.

Depending on the specific standardization effort, a standard may choose to include document definitions and vocabularies all integrated in one standard specification, whereas some other standards may separate them for easy maintenance.

5.4.2. E-commerce standards

In this subsection, we separate standards based on business functions as well as the four aforementioned layers – document semantics, vocabulary, identification, and syntax. The effort is by no means comprehensive. For instance, in area of transportation, different standards have been developed for each transportation modality such as ocean, rail, truck, and air. This section shows complexity of the landscape of standards applicable to e-commerce.

	Product listing	Packaging, labeling, sorting, picking	Transportation	Safety, quality	Storage	Monitoring	Classification
Document semantics		GS1 AI WCO data model ANSI Z535.4-2011	UN/CEFACT GS1 AI WCO data model UPU-WCO	essCert (eCO) Electronic sanitary and phytosanitary certificates eCERT	GS1 AI	GS1 AI	U.S. ITC WCO
Vocabulary	GPC	GPC UNSPSC GS1 SSCC WCO data model ISO 21067: 2007	GPC UNSPSC WCO data model UPU	ISO 10377:2013 ASTM F2923 IECEE CB scheme	GPC UNSPSC	GPC UNSPSC	U.S. ITC WCO
Identification	GS1 identification	GS1 identification EPC UNSPSC Sector specific standards	GS1 Identification EPC UPU UNSPSC GS1 SSCC		GS1 Identification EPC UNSPSC	GS1 Identification EPC UNSPSC	
Syntactic		EPCIS EANCOM GS1 XML WCO data model	EANCOM EPCIS GS1 XML UN/CEFACT WCO data model UPU-WCO	eCERT	EANCOM EPCIS GS1 XML	EANCOM EPCIS GS1 XML	WCO

)

Figure 5.8: Summary of some e-commerce standards.

5.4.2.1. Syntactic

GS1 EANCOM are GS1 eCom Electronic Data Interchange (EDI) standards that integrate information sent electronically with the physical flow of goods. Both EANCOM and GS1 XML provide electronic business messages. EANCOM is a subset of EDI messages, whereas

GS1 XML uses XML to encode messages. Both EANCOM and GS1 XML support compatible business functions such as trade transactions (catalogues, orders, invoices), instruction of transport services, settlement of trade transactions. The WCO data model includes definitions of the Customs procedures and processes as contained in the Revised Kyoto Convention [55, 58]. Despite some differences, ACE data model closely follows the WCO data model [45].

Electronic Product Code Information Service (EPCIS) is a standard for sharing information between trading partners that is related to the EPC. EPCIS is a bridge between the physical world and the information systems, as it facilitates internal data capture as well as secure external sharing of information about movement and status of goods in the physical world.

WCO-UPU standards are EDI messaging standards for global postal network, jointly developed by the WCO and UPU. We will discuss postal data sharing in chapter 8.

United Nations Center for Trade Facilitation and Electronic Business (UN/CEFACT) has been developing and supplying an array of standards in e-business processes, supply chain management, logistics planning and transport. Many intermediary to intermediary data exchanges within e-commerce environment could be covered as use cases of UN/CEFACT B2B standards. UN/CEFACT standards often include both syntax and semantic specifications. UN/CEFACT has developed standards applicable to e-commerce logistics focusing on tracking movements of goods, and transport status.

eCert specifies the standard used to exchange sanitary and phytosanitary certificates. It was developed to be used between governments.

5.4.2.2. Vocabulary

Both GS1 GPC and United Nations Standard Products and Services Code (UNSPSC) provide vocabularies for product classification. UNSPSC specifies a framework to globally classify all products and services, while GPC develops detailed classification attributes that cover a broad range of products. WCO and USITC focus on tariff code classification. It is common that e-commerce marketplaces have developed their own product categorization systems. There is a need to develop automated and AI based approach that can accurately map products from one classification scheme to another. This not only assists intermediaries and authorities to identify high risk product categories and listed products with safety concerns in a more uniform and consistent manner, but also helps online sellers to manage products listed in multiple platforms.

There are many standards specifically developed to address safety requirements and processes to test as well as to certify products that meet such requirements. Most of these standards focus on products in particular product areas. For instance, ISO 10377:2013 provides practical guidance to the suppliers on assessing and managing safety of consumer products, including effective documentation of risk assessment and risk management to meet applicable requirements. Another example is ASTM F2923. It establishes requirements and test methods for specified elements and certain mechanical hazards in children's jewelry.

ECEE CB Scheme is an international system for mutual acceptance of test reports and certificates dealing with the safety of electrical and electronic components, equipment and products.

There are many standards that define vocabularies on labeling and packaging. For instance ISO 21067:2007 specifies preferred terms and definitions related to packaging and materials handling for use in international commerce.

5.4.2.3. Document definition

UN/CEFACT has developed many business process standards that could be applied to data exchanges between two e-commerce stakeholders including both B2B and B2G use cases. These cover instructions from marketplaces provided to warehouses and/or transport intermediaries captured by traditional e-Business standards. In addition, UN/CEFACT standards apply to transfer of information from platforms to broker agents for regulatory purposes.

essCert is an Electronic Certificate of Origin (eCO) solution. It targets Chambers of Commerce, authorizing bodies, exporters, and logistics service providers for applying, issuing, and managing certificates of origin. GS1 Application Identifiers are used to connect physical things and logical things to information or business messages related to them.

5.4.2.4. Identification

GS1 has developed a set of standards for identification. Most of these standards are complementary because they target different use case areas or focus on identification at different levels. Those worth mentioning include : GLN (physical, functional or legal locations that need to be identified in the supply chain, such as physical locations of warehouses, manufacturers); SSCC (physical units that need to be tracked and traced individually in the supply chain); and GTIN. GTIN only identifies product types instead of individual object of a particular product type. However, GTIN can be serialized, so-called Serialized Global Trade Item Number (SGTIN), result of a GTIN product identifier with a unique serial number. It is worth mentioning that SSCC has been proposed to be used as unified scheme to track parcels shipped over postal network and express carriers for both B2B and B2C transactions.

Identification on product level is also facilitated by United Nations Standard Products and Services Code (UNSPSC). In addition to a product classification scheme, UNSPSC assigns codes to the product classes. The Electronic Product Code (EPC) is an identifier framework, designed to be stored on a RFID tag, EPC is a unique number that identifies a specific item in the supply chain. The EPC can be associated with dynamic data such as the origination point of an item, date of manufacture, origin and destination of shipment. For tracking, ISO standard 15459-1 defines carrier independent tracking numbers. DHL Express supports ISO 15459-1 style tracking number.

5.4.3. Standards interoperability

The EIF framework defines interoperability as: “the ability of organizations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organizations, through the business processes they support, by means of the exchange of data between their ICT systems” [28]. EIF specifies different levels of interoperability that include: legal, organizational, semantic, and technical.

Figure 5.9: EIF standard interoperability levels.

For a data sharing scheme to work effectively and smoothly, stakeholders need to consider interoperability issues at all levels. Interoperability of standards becomes even more critical when there is a plurality of federated data infrastructures for e-commerce. Legal interoperability is especially relevant to authorities. There are interoperability issues in context of G2G data sharing, and data exchanges between different countries such as mutual recognition of e-commerce related certificates, AEOs, IP registration, and documents.

At the technology level, supply and logistics industries have heavily relied on EDIFACT, and EDI for commerce, administration, and transport. Other standards include XML, W3C XML Schema Definition Language (XSD), JSON(Java Script Object Notation - key-value pair based scheme), and RDF(Resource Description Framework - developed specifically for representing linked data).

Alignment of data sharing standards requires a common representation at meta data level. At semantic level, Ontology Web Language (OWL)(Ontology Web Language developed by W3C) is a well established scheme for semantics representation. OWL is a tool developed to model semantics of data shared via the web. OWL and its meta-model are standardized by the World Wide Web Consortium (W3C).

OWL is a computational logic-based language to represent relations between things and concepts such as knowledge. As a result, semantic information expressed in OWL can be processed using automated computer software, to infer and create new knowledge. OWL models are known as ontologies.

To support automated and flexible data sharing in an environment of multiple domains of trade related electronic data objects and data structures specified by the UN/CEFACT, GS1, NIEM, WCO, etc, ontologies may hold the key to bridge and map different semantic models of trade developed by different standardization entities. With a conceptual semantic model of e-commerce, model transformation tools can be developed to export ontology representations to bridge different ontologies of trade and e-commerce supply chains, and perform semantic mapping of data objects.

Both WCO and UN/CEFACT have used proprietary meta models for representing semantics of data. The proprietary meta model supports the process of development of standard messages and related XML schema definitions. WCO has used meta model to develop the WCO data model.

SELIS [44] is a project supported by European Union's Horizon 2020 research and innovation programme to develop shared logistics information framework that includes defining and producing OWL based ontology for supply chain knowledge mapping that can support multiple standards including WCO, UN/CEFACT, GS1, NIEM, etc.

It is recognized that currently there is a lack of higher level standards (organizational and legal). There are no legal or policy level open standards to support standard interopreability as defined by the EIF.

6

Roles of technologies

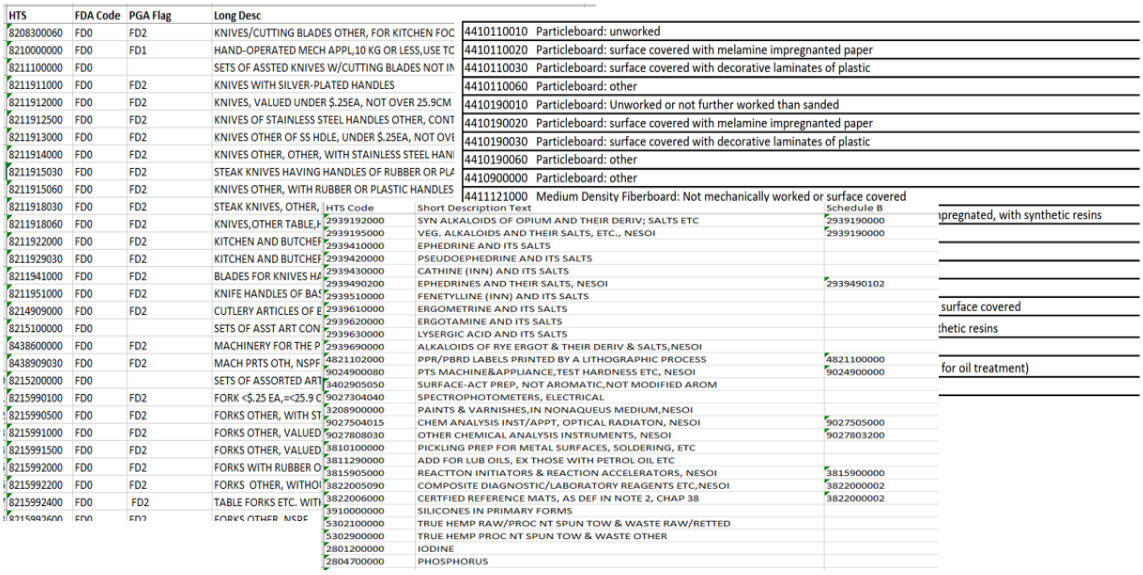
Technologies can be applied to augment and enhance data sharing and cooperation among stakeholders. This chapter will look into three main technology areas, Artificial Intelligence (AI) / Machine Learning (ML), Distributed Ledger Technology (DLT), and linked data related technologies. The potential benefits that these technologies could bring include ; improved data quality, reduced labor cost for both intermediaries and sellers, increased automation, enriched data sources, enhanced data interoperability, reduction of fraud, and improved accountability.

6.1. Artificial intelligence and automated classification

Customs authority and partner agencies rely on accurate classification of imported products for many main functionalities such as : determination of admissibility of the imported goods; qualification for preferential or special treatment (trade agreements, tariff exemption); risk based targeting for harmful, or infringing products, calculation of duties, taxes and fees; determination of permits, license and certificates required (e.g., PGA data) ; and collection of trade statistics. With growing popularity of cross-border e-commerce and increasing amount of parcels that arrive at the U.S. port of entries, Customs authority is facing significant data quality challenges regarding e-commerce parcels.

More accurate product classification for e-commerce imports could improve risk management and increase targeting effectiveness for the Customs authority and partner government agencies. It has benefits to the trade side stakeholders as well, as correct classification could expedite the customs clearance process by avoiding unnecessary non-compliance which can cause delays.

Figure 6.1 illustrates that HTS classification is used by the PGAs to determine if additional data items are necessary to be submitted.



HTS	FDA Code	PGA Flag	Long Desc
8208300060	FD0	FD2	KNIVES/CUTTING BLADES OTHER, FOR KITCHEN FOC
8210000000	FD0	FD1	HAND-OPERATED MECH APPL,10 KG OR LESS,USE TC
8211100000	FD0		SETS OF ASSTED KNIVES W/CUTTING BLADES NOT IN
8211911000	FD0	FD2	KNIVES WITH SILVER-PLATED HANDLES
8211912000	FD0	FD2	KNIVES, VALUED UNDER $.25EA, NOT OVER 25.9CM
8211912500	FD0	FD2	KNIVES OF STAINLESS STEEL HANDLES OTHER, CONT
8211913000	FD0	FD2	KNIVES OTHER OF SS HDLE, UNDER $.25EA, NOT OVE
8211914000	FD0	FD2	KNIVES OTHER, OTHER, WITH STAINLESS STEEL HANI
8211915030	FD0	FD2	STEAK KNIVES HAVING HANDLES OF RUBBER OR PLA
8211915060	FD0	FD2	KNIVES OTHER, WITH RUBBER OR PLASTIC HANDLES
8211918030	FD0	FD2	STEAK KNIVES, OTHER,
8211918060	FD0	FD2	KNIVES,OTHER TABLE,K
8211922000	FD0	FD2	KITCHEN AND BUTCHEF
8211929030	FD0	FD2	KITCHEN AND BUTCHEF
8211941000	FD0	FD2	BLADES FOR KNIVES HA
8211951000	FD0	FD2	KNIFE HANDLES OF BAS
8214909000	FD0	FD2	CUTLERY ARTICLES OF E
8215100000	FD0		SETS OF ASST ART CON
8438600000	FD0	FD2	MACHINERY FOR THE P
8438909030	FD0	FD2	MACH PRTS OTH, NSPF
8215200000	FD0		SETS OF ASSORTED ART
8215990100	FD0	FD2	FORK <$.25 EA,=<25.9 C
8215990500	FD0	FD2	FORKS OTHER, WITH ST
8215991000	FD0	FD2	FORKS OTHER, VALUED
8215991500	FD0	FD2	FORKS OTHER, VALUED
8215992000	FD0	FD2	FORKS WITH RUBBER O
8215992200	FD0	FD2	FORKS OTHER, WITHOI
8215992400	FD0	FD2	TABLE FORKS ETC. WITH
8215993600	FD0	FD2	FORKS OTHER, NSPF

4410110010	Particleboard: unworked
4410110020	Particleboard: surface covered with melamine impregnanted paper
4410110030	Particleboard: surface covered with decorative laminates of plastic
4410110060	Particleboard: other
4410190010	Particleboard: Unworked or not further worked than sanded
4410190020	Particleboard: surface covered with melamine impregnanted paper
4410190030	Particleboard: surface covered with decorative laminates of plastic
4410190060	Particleboard: other
4410900000	Particleboard: other
4411121000	Medium Density Fiberboard: Not mechanically worked or surface covered

HTS Code	Short Description Text	Schedule B
2939192000	SYN ALKALOIDS OF OPIUM AND THEIR DERIV; SALTS ETC	2939190000
2939195000	VEG. ALKALOIDS AND THEIR SALTS, ETC., NESOI	2939190000
2939410000	EPHEDRINE AND ITS SALTS	
2939420000	PSEUDOEPHEDRINE AND ITS SALTS	
2939430000	CATHINE (INN) AND ITS SALTS	
2939490200	EPHEDRINES AND THEIR SALTS, NESOI	2939490102
2939510000	FENETYLLINE (INN) AND ITS SALTS	
2939610000	ERGOMETRINE AND ITS SALTS	
2939620000	ERGOTAMINE AND ITS SALTS	
2939630000	LYSERGIC ACID AND ITS SALTS	
2939690000	ALKALOIDS OF RYE ERGOT & THEIR DERIV & SALTS,NESOI	
4821102000	PPR/PBRD LABELS PRINTED BY A LITHOGRAPHIC PROCESS	4821100000
9024900080	PTS MACHINE&APPLIANCE,TEST HARDNESS ETC, NESOI	9024900000
3402905050	SURFACE-ACT PREP, NOT AROMATIC,NOT MODIFIED AROM	
9027304040	SPECTROPHOTOMETERS, ELECTRICAL	
3208900000	PAINTS & VARNISHES,IN NONAQUEUS MEDIUM,NESOI	
9027504015	CHEM ANALYSIS INST/APPT, OPTICAL RADIATON, NESOI	9027505000
9027808030	OTHER CHEMICAL ANALYSIS INSTRUMENTS, NESOI	9027803200
3810100000	PICKLING PREP FOR METAL SURFACES, SOLDERING, ETC	
3811290000	ADD FOR LUB OILS, EX THOSE WITH PETROL OIL ETC	
3815905000	REACTTON INITIATORS & REACTION ACCELERATORS, NESOI	3815900000
3822005090	COMPOSITE DIAGNOSTIC/LABORATORY REAGENTS ETC,NESOI	3822000002
3822006000	CERTFIED REFERENCE MATS, AS DEF IN NOTE 2, CHAP 38	3822000002
3910000000	SILICONES IN PRIMARY FORMS	
5302100000	TRUE HEMP RAW/PROC NT SPUN TOW & WASTE RAW/RETTED	
5302900000	TRUE HEMP PROC NT SPUN TOW & WASTE OTHER	
2801200000	IODINE	
2804700000	PHOSPHORUS	

Figure 6.1: Illustration of HTS classification used by PGAs to determine if additional data items are necessary to be submitted for determining admissibility.

There are gaps in obtaining accurate product information and classification for e-commerce parcels. Amazon itself has an inventory of about 12 million items across all its categories and services. Inclusion of all the items that the Amazon marketplace sellers list the number expands to about 350 million. Product pages are updated on daily basis. The sheer number of C2C and B2C transactions between sellers and consumers makes manual classification impractical and it becomes seemingly impossible to accurately determine whether certain transactions require PGA data. In many cases, both sellers and buyers are not knowledgeable of trade compliance, HTS classification, and rules of cross-border customs clearance. Currently, only very few platforms provide tools or assistance to the customers on classification.

In addition, accurate HTS classification is rather challenging to achieve for many reasons. These difficulties include HTS complexity itself as a structured multipurpose nomenclature, gaps in terminology (e.g., a wooden chair could be classified according to material condition or its function as furniture), and the constantly evolving nature of HTS Code (frequent changes and updates).

On the other hand, platforms and marketplaces are sitting on top of rich and vast amounts of data created by both the sellers and consumers. These include product data uploaded by the sellers such as product descriptions, specifications, and pictures; as well as data contributed from consumers such as comments, questions/answers regarding the products (e.g., questions related to functionality, usage, components, materials), ratings, etc. All could be used as inputs to an automated and AI/ML based approach to more accurately classify the products. The current abundance of e-commence data and advanced machine learning techniques provide an opportunity for cross-border e-commerce stakeholders to classify goods more accurately and efficiently at much lower cost. Recognizing this oppor-

Table 6.1: Summary of published work applying ML for HS classification.

Report	**Data Format**	**ML Approach**	**Dataset**
[25]	text	Background Nets	text samples for HS codes Chapter 22 and Chapter 90
[33]	text	CNN	scraped data from e-commerce websites (911,990-1, 990-2, 919)
[33]	pictures	CNN	scraped data from e-commerce websites (911,990-1, 990-2, 919)
[33]	text+pictures	CNN	scraped data from e-commerce websites (911,990-1, 990-2, 919)
[3]	text	Naïve Bayes, K-Nearest Neighbor, Decision Tree, Random Forest, Linear Support Vector Machine and Adaboost	Dubai Customs dataset Oct 2019

tunity, there have been efforts in both private industry and academia to explore this new frontier.

Several published efforts have applied deep ML neural network based approaches to auto-classification of products based on text descriptions of the goods [3, 13]. These endeavors have shown encouraging results of such methodology in product classification with ill-defined vocabularies and complex semantics. A pilot supported by the Canadian Customs investigated detecting HS classification errors with natural language processing tools [31]. The proprietary artificial intelligence software processes, interprets and analyzes text description of imported commodity. It has been demonstrated with high levels of reliability and accuracy in HS classification and HS code verification.

In addition to text descriptions, efforts continue investigation of HS classification based on product pictures using ML and deep neural network. Furthermore, it is possible to fuse classification results from both text descriptions and product pictures to enhance accuracy.

Most of these approaches utilize product information publicly available on e-commerce platforms and marketplaces. The efforts could lead to powerful auto-classification tools to Customs authority when e-commerce intermediaries and stakeholders start to share product information on their platforms (e.g., product listing data) with the authorities under various e-commerce oriented data sharing programs (e.g., Section 321 data pilot, or data sharing approaches described in chapter 5).

Auto-classification tools could improve capabilities of intermediaries to detect high risk products or products that have various PGA data requirements. Figure 6.2 depicts a possi-

ble process that a marketplace or platform could utilize to automate the decision whether additional documents or data is needed from a seller. Adoption of such a process has potential benefits such as reduced uncertainty of cross-border e-commerce shipping, increased satisfactory from consumers, etc.

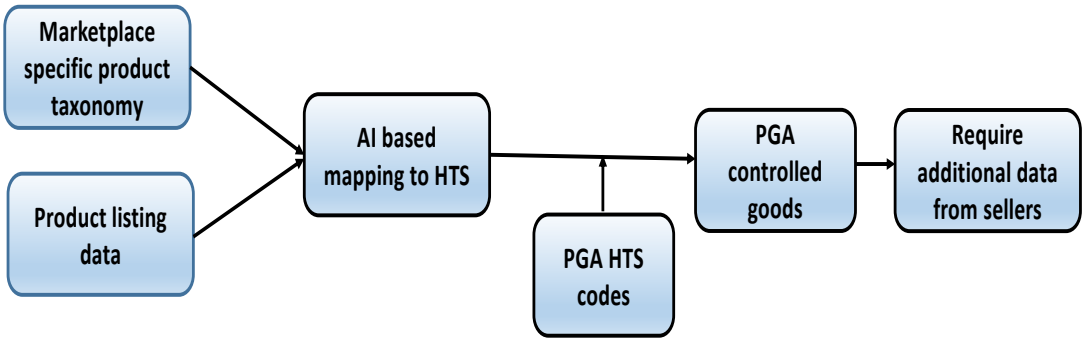


Figure 6.2: Process using auto-classification tools by an intermediary (marketplace, platform, fulfillment center) to determine if a product is restricted by PGAs or needs additional data for meeting PGA requirements.

It is likely that in the future, upon wide adoption of auto-classification tools by the e-commerce stakeholders, accountability and transparency may become an issue. AI based auto-classification tools may have different qualities in terms of metrics such as accuracy, rates of false positives/false negatives. It is known that certain product categories are more difficult to classify accurately than others. Using the same auto-classification tool, depending on the amount of data and types of data available as inputs for a product to determine its classification, quality of the result may differ significantly, often measured as confidence level. Furthermore, ML models are trained each time it makes a mistake. The models certainly will evolve over time. All these create a future need to have auto-classification tools certified and registered by the Customs authority and regulatory agencies.

When a parcel arrives at a port of entry with an entry declaration where classification is done with fully automated tools and the tools have various qualities (e.g., one classification tool tends to make mistakes in one product category whereas another tool more often has mistakes in some other categories), knowing context information of classification such as confidence level of classification, actual reference to the tool used, and certified performance results, would be useful for Customs to determine quality of the data received and decide import risk level.

A possible approach is to leverage DLT where each time a product is classified by an auto-classification tool, the context information (e.g., time, classification tool used, unique link to the actual listed product, confidence level, classification result) can be recorded on a distributed ledger and later verified by Customs.

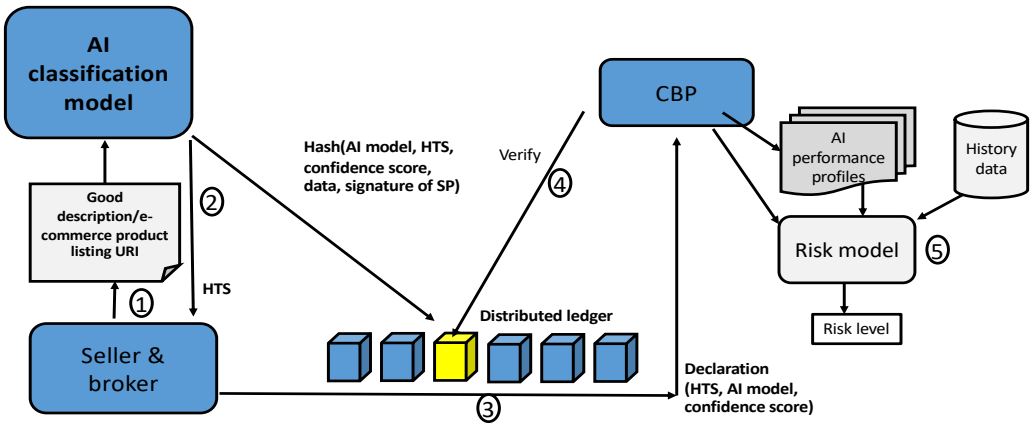


Figure 6.3: Accountability of auto-classification tools.

6.2. Distributed ledger technology

Another emerging technology area that could bring tremendous benefits to e-commerce data sharing is DLT. The potential of DLT for its applications in cross-border commerce has been intensively investigated in recent years [19, 39, 47]. This section will focus primarily on capabilities of DLT being applied to enhance e-commerce data sharing within private stakeholder communities in e-commerce, and between trade and authorities.

6.2.1. Enhance federated data platform

DLT can enhance and augment federated data platform that by design is based on the concept of decentralization and cooperation of nodes that are owned or operated by a community of stakeholders. A federated data infrastructure not necessarily solely depends on application of DLT. However, a hybrid design that integrates DLT with other technology components such as cloud based infrastructures (e.g., distributed ledger as-a-service, Amazon's Quantum Ledger Database), mobile devices, and IoTs could yield beneficial results.

Areas DLT is ideally suited for include data quality and data integrity in context that data is stored and shared over a network of nodes in a federated infrastructure. These could encompass:

- **Correctness**: Data reflects a real-world situation regarding a seller, product, a transaction, parties involved, as well as physical flow of goods, for instance, data attribute indicating if a product has FDA registration.
- **Consistency**: Data from multiple sources or views of the data by stakeholders that reflect the same physical or logical situation should be identical. "Brushing scam" is an

example of inconsistency where IT system of marketplace may record a transaction of products different from what is actually shipped.

- **Unambiguous**: A piece of data recorded in the system can only be interpreted in one way with agreed semantics by the stakeholders.
- **Completeness**: A set of data contains all the necessary data items according to relevant standards or requirements, for instance, a transaction missing consignee information will be incomplete.

There are many reasons that could result in poor data quality or low data integrity, for instance, data corruption or data loss due to ICT failures, data tampering by malicious insiders or bad actors through successful cyber attacks, fraudulent or false data by those who commit fraud in cross-border transactions, or data errors introduced by human operators when data is copied or duplicated.

DLT could safeguard against exploits and prevent data from being tampered. As a result, it proactively protects data integrity and prevents many fraudulent situations around data from occurring. It enables assurance of data consistency with its built-in consensus based data update protocols. In a DLT based system, integrity codes (e.g., hash values) are distributed across a community of nodes, which makes the data kept using DLT very difficult to be tampered by bad cyber actors. In DLT, hash code can be applied to protect a piece of record or an entire document, the codes can be chained, which enables immutability (data cannot be altered later in time or back dated), and irrefutability (there is no denying after data is shared).

In a DLT based infrastructure, data records can be distributed over a set of nodes therefore it is resilient against single point of failures, or cyber attacks or disruptive events (natural or man-made) that cause data to become unavailable to other stakeholders. As summarized by the WCO [39, 60], DLT could provide the benefits such that increased assurance that shared data is from the source where it is generated – leading to improved trust and accountability of the information; single version of truth – where stakeholders have the same level of visibility to shared information such as certificates and status information; improved authenticity of trade related documents and data because it is much more difficult to generate forged documents when data is kept in a system protected by DLT.

6.2.2. Certified/verified once, accepted everywhere

As discussed in chapter 5, there are concerns that large intermediaries and e-commerce market participants may gain competitive advantages over MSMEs in broadened data sharing programs as these dominant players have financial and human resources to implement best practice guidelines (e.g., more rigorous vetting of sellers and listed products, detection of IPR violations) and invest in new technologies in compliance and data sharing.

It is anticipated that DLT could be a candidate technology to “level the playing field” for

MSMEs to operate globally. One benefit DLT could bring, after broad adoption, is to lower transaction costs and increase transparency, which could benefit MSMEs.

As the intermediaries start to bear more burdens to vet online sellers and their listed products, technologies that can streamline and improve the process at the same time reduce the cost of compliance would be needed. DLT provides such opportunity so that after a product is verified to meet safety standards and PGA requirements, the information can be recorded on a distributed ledger, and shared with involved intermediaries. When the product is listed on a platform, seller can make various claims about the product. The platform can verify these claims against claims recorded on the distributed ledger. If shared with the Customs authorities, the claims can be verified easily as well against the record on the ledger by the authorities.

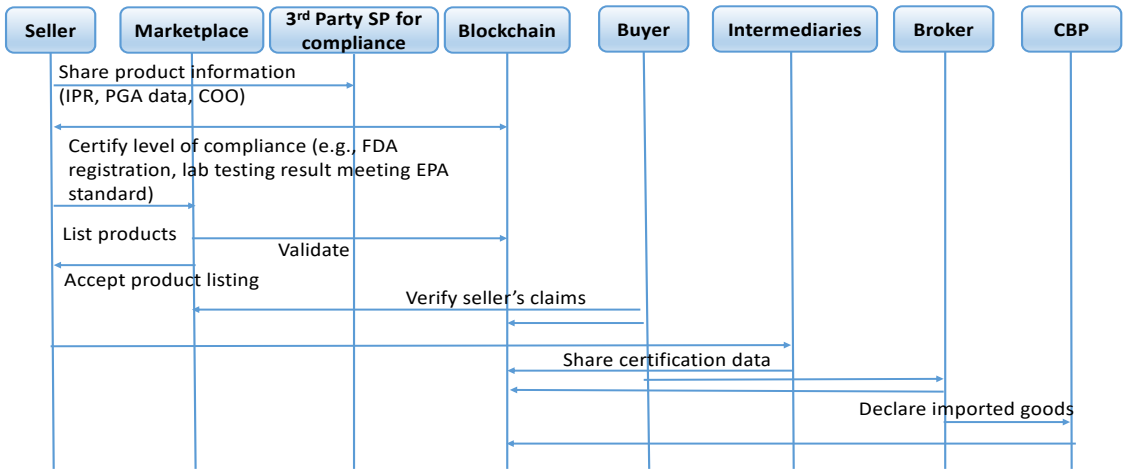


Figure 6.4: Use case of DLT: certified/verified once, use it everywhere in the e-commerce environment.

Claims that can be verified include but not limited to: satisfaction of PGA requirements (e.g., registration), IPR licenses (e.g., product made by licensed manufacturer), COO, manufacturer data, authenticity of LPCO, testing results by accredited labs, etc.

The benefits include: lower cost to intermediaries and sellers (verified once and accepted everywhere), and improved resilience against frauds (e.g., document forgery, false claims).

Another exemplary use case is vetting of FDA restricted products by e-commerce intermediaries. For legitimate concerns, right now, FDA does not support online verification of registration by third party. The practice is not well suited for e-commerce process and B2C transactions. There is a lack of automation support. Intermediaries cannot directly verify claim of FDA registration. The typical practice is that vendors take screenshots after login and share the screenshots with intermediaries or buyers as proof of FDA registration. This approach has high administrative cost. DLT based Oracle service could bring a remedy to the situation. The process is shown in Figure 6.5. Working jointly with Oracle service provider, a publicly verifiable proof of FDA registration can be recorded on a distributed

ledger. The recorded proof allows a claim of FDA registration to be verified by any intermediary.

A major advantage of this approach is that it is interoperable with the existing FDA service interface. It does not require FDA to change its current registration service. This approach can work with other private or public entities that provide certifications, licenses, testing results, or permits. It requires no change of the existing infrastructure.

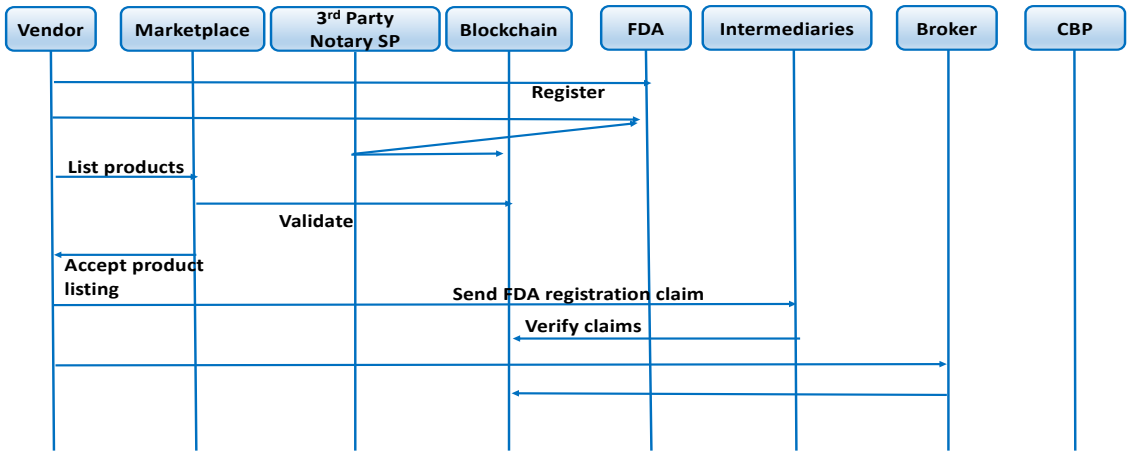


Figure 6.5: DLT based verification of claims (FDA registration as an example).

6.3. Linked data and related technologies

Linked open data in e-commerce is an approach to capture data from original and heterogeneous data resources, and connect the data as a database of knowledge for analysis using well defined standards of semantics (e.g., ontology). Linked open data can be applied to construct knowledge base of e-commerce for risk analysis. A main benefit of linked open data is that it supports data obtained from heterogeneous data resources (e.g., associating and linking data captured from multiple marketplaces, manufacturer websites, product registration websites).

6.3.1. Background

The approach enables integration of many heterogeneous data in different sources by constructing links between the data. Resources are identified by their URIs (Uniform Resource Identifier). RDF is applied for describing links between resources. Standards such as OWL can be applied in conjunction to represent data semantics. It is envisioned that in e-commerce, by publishing and sharing linked data, stakeholders can contribute to the creation of a web of e-commerce data, which can lower the barrier to integration and application of data from multiple, decentralized and heterogeneous sources. There have been efforts to develop supply chain visibility support by leveraging linked data based approaches.

6.3.2. Opportunities

Linked data related standards and technologies create opportunities to construct knowledge based databases for e-commerce from public data sources (both structured data and unstructured data) that can assist the Customs authorities to assess import risks and improve targeting capabilities. Private sector efforts focusing on e-commerce data analytics have leveraged such technologies to construct knowledge graphs of e-commerce based on data collected from a wide range of sources to assist private sector stakeholders to make decisions (e.g., branding, optimizing product listing). There is no doubt that the approaches could bring significant benefits to the Customs authorities and partner government agencies. Linked data based approach could be an important piece of the puzzle, as enabling technology for Customs to achieve a modernized and intelligence based decision support system regarding cross-border e-commerce imports.

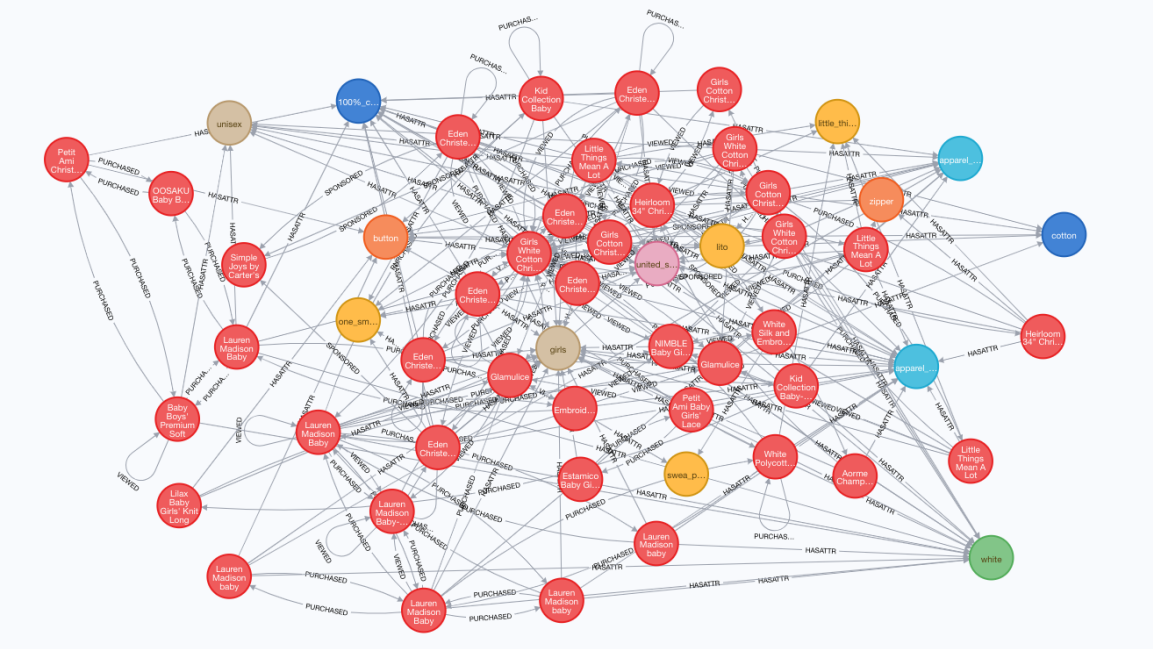


Figure 6.6: Example of product knowledge graph constructed from open data sources (https://www.semantics3.com/blog/the-ecommerce-knowledge-graph-semantics3-labs/).

Figure 6.6 demonstrates product knowledge graph created by curating and understanding public product data from across e-commerce platforms. As described by Semantics3, a company focusing on data analytics of e-commerce data, dataset includes information of tens of millions of products with over a thousand of standardized attributes can be collected from multiple public data sources (e.g., billions of attribute values). The dataset can be processed using AI based classification technologies that can group products into meta-classes. Then graph tools are applied to create e-commerce knowledge graph to harness the value of the relationships between the entities.

The data collected from various sources (e.g., product listing in marketplaces, manufacturers' websites, consumer interactions with sellers, consumer comments, websites of prod-

uct registrations) may be in different formats. Leveraging ontology based semantics information, these diverse datasets can be connected together, which increases their value and assists authorities in identifying relationships among them and gain a complete picture of information, whether it is about a product or a seller.

Ontology offers a well-defined and systematic approach to describe semantics of data resources. It can be used to specify domain concepts, properties of those concepts, relationships among concepts and properties that are of interest to a community. RDF is a general-purpose knowledge representation tool that provides a means for describing a resource (can be identified using Universal Resource Identifier (URI)) or defining an ontology. As shown in Fig 6.7, for purpose of Customs functionality, it is possible to develop an ontology model based on the WCO's data model and other data models that are within the scope of interests by the Customs authorities and partner agencies.

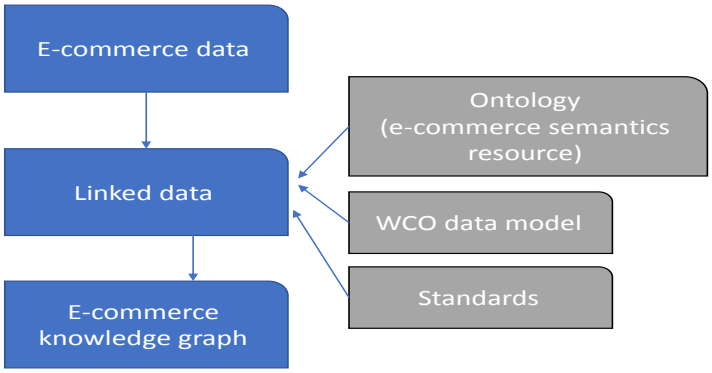


Figure 6.7: Apply linked data and semantics information to construct knowledge database for e-commerce from heterogeneous sources.

For completeness, there are various data resources from the private sector, government websites, non-profit organizations as illustrated in Fig 6.8. These include marketplaces, social media, government databases, registration portals managed by the partner agencies, USPTO, etc. The datasets can be structured or unstructured. To minimize burdens of administrative agreements, web scraping or crawling based approach can be used to retrieve all open data, metadata and links of those resources. It captures data from all the relevant stakeholders of the e-commerce environment. Collected data can be aggregated and linked together based on semantics and ontology. Distinguishing from the commercial efforts that apply linked data and product semantics processing to create a knowledge base to optimize e-commerce sales, e-commerce supply chain stakeholders and the Customs authorities could apply the same technologies and tools for assessing various types of import risks of e-commerce products and sellers.

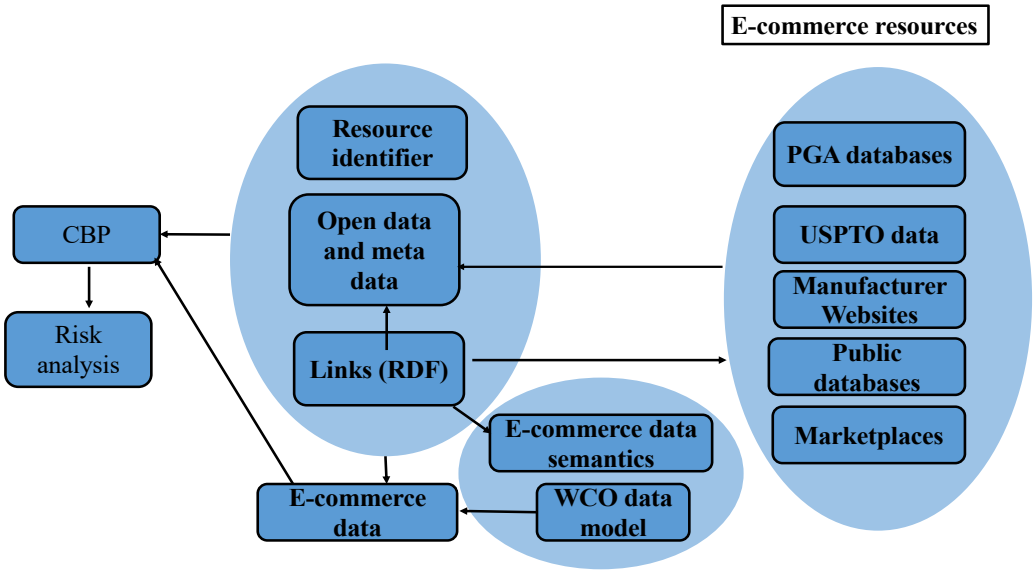


Figure 6.8: Linked data of e-commerce for risk based decision support.

It is worth mentioning that linked data based approach works with other mechanisms of data collection, for instance, data pulled or retrieved using an API interface. This means that e-commerce data from federated data platforms like these described in chapter 5 can be supported as well. For a federated data platform that adopts linked data standards for data sharing, when authorities look up a URI, under linked data standards, it provides links to other URIs, so that authorities can discover new data sources by following the RDF links.

6.3.3. Decentralized e-commerce product information stores

One specific use case of linked data related to product information is the possibility to construct a decentralized e-commerce product data catalogs which enables the reality of a web of linked product information. Such data sources if linked to e-commerce shipping data (assume that through various data sharing programs with e-commerce stakeholders/intermediaries, Customs authorities can obtain links between goods contained in parcels and product identifiers in decentralized e-commerce product data catalogs) can greatly enhance capabilities of the Customs authorities for carrying out risk determination.

Decentralized e-commerce product data catalogs can provide benefits to the private sector

stakeholders so that government authorities could piggyback efforts of the private sector e-commerce stakeholders. Leveraging standardized linked data formats and standardized interfaces, such data catalogs can eliminate ambiguities, reduce the need for manual re-entry of data and enable efficient sharing of product data across the e-commerce environment. Standalone data stores of such nature already exist led by the private sector players. An emerging frontier is to connect and integrate these data sources into a federated environment or data hub so that they can be linked based on open standards of semantics.

In Appendix L, one can find an example of GPC product code and its plausible conversion to RDF based representation after mapping product identifiers, attributes and categories as a set of RDFs.

It is important to highlight that ontology differs from taxonomies and traditional classification structures. An ontology is neither a taxonomy nor a classification scheme [29].

A taxonomy or traditional classification scheme organizes the knowledge of a domain by identifying the essential or defining characteristics of domain entities thus allowing creation of a hierarchical ordering of mutually exclusive classes to which the entities themselves are then assigned. In contrast, ontology defines a set of elements to which values may be assigned, as appropriate, in order to represent physical and/or conceptual features of a resource. It can incorporate a set of inference rules that allow inferences of the represented knowledge or identify connections across resources.

In context of product information, ontologies can be applied to enable conceptual interoperability of product data models developed by different sources and facilitates communication among different systems. To achieve this, DLT may play an enabling role as it could provide incentives and enable trusted coordination among a community of e-commerce stakeholders.

Table 6.2: Properties of decentralized product catalogs based on linked data standards.

	Existing product catalog system managed by a central entity	**Decentralized product catalogs**
Management	Regional office and/or central entity	Not centralized
Standards	GS1, and other standards	Linked data, OWL, URI, GS1, WCO, UN/CEFACT
Database providers	Approved by a central entity (e.g., GS1)	Open to any 3rd party data provider/aggregator
Availability of semantics information	No	Yes
Vetting of submitted data	Regional office and/or central entity	DLT consensus and built-in data validation process
Registration	Product owner	Not required. Data can be collected from heterogeneous sources (e.g., marketplaces, manufacturer websites, public databases) using different data collection mechanisms (e.g., web scraping, API calls)
Cost to MSMEs	Medium to high (subscription based)	Low

6.4. Digital distributed ledger: economic rationale

Leveraging a digital distributed ledger technology could increase the likelihood that CBP and other relevant importing agencies obtain required data in an expedient manner for current declaration processes. Impediments to CBP obtaining data include lack of data sharing among intermediaries, data fragmentation that makes data sharing inefficient, a seller not having a physical operation, the misreporting of information such as a parcel's volume, or new actors in the importing space such as e-commerce sellers and marketplaces not knowing how to share data.[1]

A digital distributed ledger could streamline the collection of data especially for certain types of e-commerce shipments. For example, a digital distributed ledger could require the collection of:

- Product information: category, attributes, and unique identifiers such as HTS classi-

[1]The General Accountability Office has at least three reports highlighting the need for advanced data sharing to facilitate better targeting and increased efficiency in the entry process. See [20], [21], and [23].

fication in manifest filings

- Product description: price or URL for linked data
- Seller information: seller ID, description, and risk information from sellers including PGA requirements
- Other: tracking number, port of entry, shipping mode, or consignee information

We propose a three-tiered entry approach based on the perceived risk that a shipment has insufficient data for speedy entry. We examine the effects of leveraging distributed ledger technology to address these unmet data needs as well as reduce cost and expedite customs procedures.

A three-tiered approach for perceived risk (the likelihood that CBP does not obtain sufficient data for expedient entry) includes Tier 1 with the highest risk, Tier 2 with medium risk, and Tier 3 with the lowest risk. Below we characterize the types of shipments that fall under each tier, as well as the data sharing and validation requirements (costs to data sharing).

Digital distributed ledger technology may increase expediency of legitimate trade flows, improve detection of illicit trade flows, and deter illegitimate efforts to circumvent trade rules. A digital distributed ledger can be secured by design and is nearly impossible to make a fraudulent claim or edit past transactions without the approval of the other users in the network.

The initial effect of distributed ledger technology will be operational efficiencies. Cost can be taken out of existing processes by removing the administrative effort of record keeping and transaction reconciliation. Over time, the value of digital distributed ledger will shift from driving cost reduction to enabling entirely new business models and revenue streams. One of the most promising and transformative use cases is the creation of a distributed, secure digital identity and the services associated with it.[37]

To the extent that integrating digital distributed ledger into customs procedures facilitates trade, then the effects may be like those that would accompany the complete implementation of trade facilitation measures outlined in the World Trade Organization's Trade Facilitation Agreement. For member countries belonging to the Organisation for Economic Co-operation and Development (OECD), trade costs could be reduced by 11.8 percent.[34]

6.4.1. Digital distributed ledger costs

A digital distributed ledger could facilitate the integration of e-commerce into Customs declaration. A digital unique code or identifier for transactions that is linked to pertinent information could facilitate data sharing and lower costs to data sharing for stakeholders and allow for closer monitoring and implementation of legal rules.

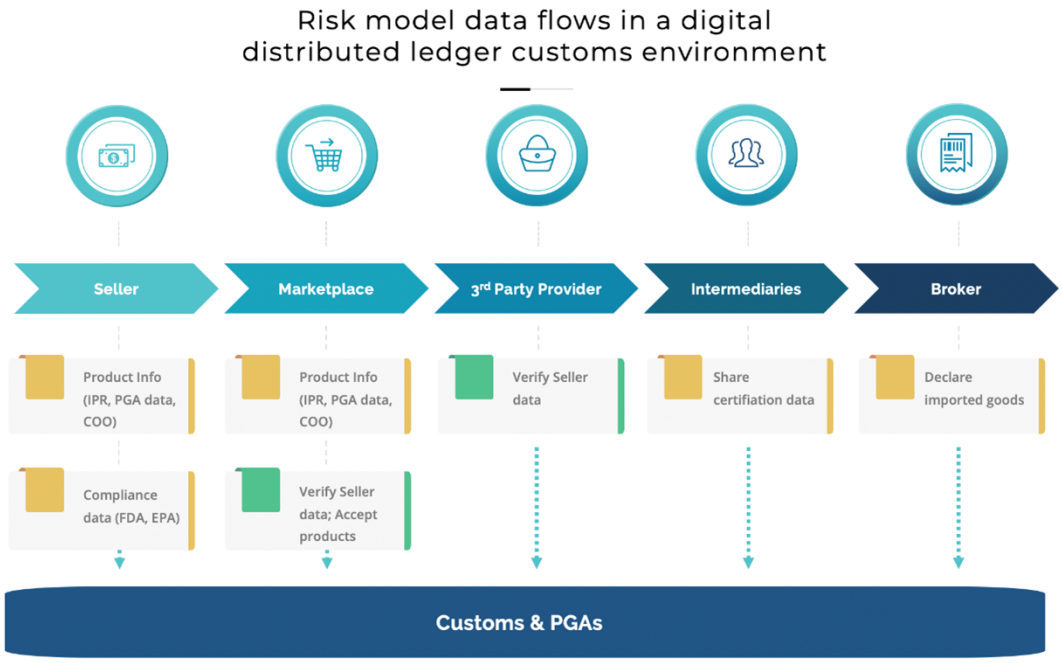


Figure 6.9: A simplified illustration of data flows in a digital distributed ledger customs environment.

In 1994, CBP and 22 other agencies developed the Automated Commercial Environment (ACE), an information system to better coordinate and streamline import processing. While the key functions of the system do yield benefits, there are limitations to the ACE environment that a digital distributed ledger may be able to harness, such as limits on file size.

Currently, e-commerce declaration procedures could be considered incomplete because they do not support retrieval of container information. Linked data from e-commerce transactions could streamline the data submission process and provide time and cost savings from additional data requirements for e-commerce. Linked data can also improve the traceability of supply chains in e-commerce, and therefore provide origin data.

In the digital distributed ledger, the flow of product information and classification can be streamlined. Submission information, or "blocks" in the digital distributed ledger, can be separated into various stakeholders such as: seller, marketplace, 3rd party service providers, brokers, and other intermediaries. Depending on the level of risk associated with the shipment, the amount of information required and the levels of verification may vary. We provide a sample digital distributed ledger submission process in Figure 6.9. If at any point information is not submitted along the chain, the shipment could be rejected at the exporting firm by the carrier or could automatically trigger seizure by CBP or other importing agencies. Figure 6.9 depicts a simplified version of a data flow in a digital distributed ledger that we use in our analytical approach.

In our analysis we focus on the average cost per transaction over five years of using a digital distributed ledger. The average cost for all groups over five years ranges from $0.478 to $5.061, with a median cost of $0.858 per transaction (shipment). There are up-front costs

regardless of the type of technology employed or burden of proof on the part of the stakeholders.

Implementation and utilization costs of digital distributed ledger technology for stakeholders depends on the volume and value of transactions, as well as the verification methods to assure legitimacy of the information blocks. Such means of verification, i.e., consensus protocols, can include:

1. Proof of work: mining blocks of transactions (highest cost)
2. Proof of stake: financial assets used as an incentive to mine blocks with integrity, where proof of financial stake is submitted into the distributed ledger (medium cost)
3. Proof of authority: allocates the responsibility of verifying blocks to specified participants (lowest cost)

Onboarding and Cloud implementation are the largest costs in the public and private sector. Digital distributed ledgers with zero-knowledge proof solutions have the lowest costs over time (as technology improves), but a higher proportional financial investment on the part of the public sector. Ongoing maintenance and monitoring costs may be divided among various public and private sector entities depending on the level of risk associated with the shipment.

A study by Ernst and Young identified five potential cost scenarios of utilizing a digital distributed ledger technology solution.[15] The highest up-front cost (scenario 5) is one where all users employ a second-generation zero-knowledge proof system. The lowest up-front cost (scenario 4) is one where all users can enter data into a third-generation zero-knowledge proof public digital distributed ledger. Scenarios 1, 2, and 3 employ cloud-based centralized private distributed ledger technology and have different costs dependent on the transaction size, number of daily transactions, and how many levels of verification are required. Figure 6.10 illustrates the costs of moving to a digital distributed ledger environment over time for these scenarios, with costs including onboarding, technology, cloud maintenance and monitoring.

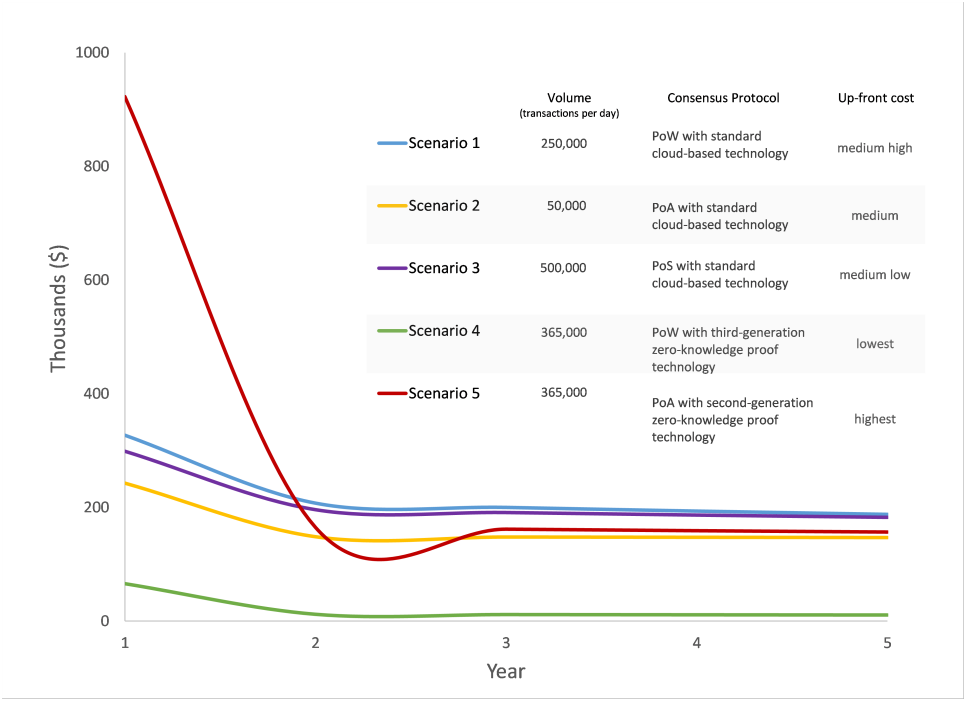


Figure 6.10: Digital distributed ledger costs over time across different volume, protocol, and cost scenarios
Source: Ernst and Young (April 2019).
Note: Consensus protocols include proof of work (PoW), proof of authority (PoA), and proof of stake (PoS).

Sellers may potentially be able to move from Scenario 1 to Scenario 2, for example, by becoming a trusted seller or being able to move risk tiers in the digital distributed ledger. As such, their consensus protocol could move from proof of work to proof of authority, and their costs could be lower.

A digital and unique identifier, or code, for each transaction could lower the cost to data sharing for all parties by streamlining traceability of individual transactions from start to finish. Having all pertinent data in a digital ledger that is distributed to key stakeholders can lower CBP monitoring costs, expedite shipments by 'good actors', improve e-commerce data quality, and enable importing agencies to more easily reject or track illicit/counterfeit shipments.

7

Economic impact analysis

In this chapter, we assess the potential impacts, including economic costs and benefits, of the WTO extended-AEO model on the U.S. government, businesses, and consumers. We also utilize a risk model to quantify the expected economic effects, on average, of leveraging digital distributed ledger technology for the government and stakeholders.

Our analysis suggests that the U.S. government will incur costs associated with implementation, maintenance, and monitoring of the digital distributed ledger, but will also benefit from cost savings. U.S. businesses, sellers, and other stakeholders likewise will see costs from implementation of the digital distributed ledger but will benefit from lower time costs and other efficiency gains. Consumers will see similar costs and benefits to importers in direct-to-consumer transactions.

A move to a digital distributed ledger will have the following effects: 1) the number of shipments where stakeholders cooperate by sending sufficient data will increase; 2) the number of shipments where stakeholders do not share sufficient data will decrease; 3) the probability that CBP and other importing agencies will obtain sufficient data will increase; 4) the digital distributed ledger costs do not drive major changes in landed costs; and, 5) the economic efficiency of the importing process will improve.

7.1. Key costs and benefits

This section discusses the key costs and benefits of a risk-based, three-tiered digital distributed ledger approach for government, businesses, sellers, and consumers.

7.1.1. U.S. government

For the U.S. government, there will be costs associated with the implementation, maintenance, and monitoring of the digital distributed ledger technologies. On the other hand, the U.S. government will benefit from cost savings associated with: 1) automatic assessment of parcels that do not have sufficient data (less uncertainty); 2) collection of tariff or duty revenue from shipments that may have otherwise circumvented duties; and, 3) a higher probability of correct and sufficient data reaching CBP and other importing agencies.

7.1.2. U.S. businesses, sellers, and other stakeholders

For sellers and other stakeholders that are compliant with data sharing, there will be implementation costs associated with the digital distributed ledger. Businesses can also expect labor and other cost savings from transitioning from the ACE environment that will recover the implementation costs over time. For U.S. businesses, i.e., importers, there will likely be benefits in savings from: 1) reduced importation time and shipment costs; 2) long-run administrative cost savings from hours worked on paperwork; 3) efficiency gains from reductions in dwell time; 4) protection of intellectual property; 5) excluding products that may circumvent trade laws such as anti-dumping and countervailing duty laws; and, 6) cost and time savings from identification of unsafe goods (based on consumer safety standards).

7.1.3. U.S. consumers

U.S. consumers will experience costs and benefits like those expected for importers in direct-to-consumer markets, such as savings from shipment costs and dwell time, and a lower probability of receiving a counterfeit or unsafe good. A key result from incorporating distributed ledger technology is the overall reduction in trade costs, which in principle results in lower importer and consumer prices and greater variety depending on the product and market.

7.2. Analytical framework

This section discusses the analytical framework for estimating the economic effects of leveraging a distributed ledger technology solution to streamlining the customs process. We focus on the average effects for one shipment of a transition from standard CBP import practices to incorporating digital distributed ledger technology and incorporate key elements of the changing e-commerce importing environment and de minimis value shipments. We apply standard techniques to estimate the direct effects of a transition to digital distributed ledger on U.S. government, businesses, and consumers.

We estimated the government cost of monitoring shipments as well as the benefit of easier

identification of illicit packages. For U.S. consumers and businesses, we estimated the time and cost savings from changing dwell time. Finally, for sellers and other stakeholders, we estimated the trade-off between implementation and utilization costs of digital distributed ledger and lower dwell time for those who cooperate.

The effects on businesses depends on their level of cooperation and their willingness to share sufficient data for speedy entry. For purposes of simplicity, we delineated between businesses who cooperate and those who do not. This model does not try to estimate the indirect or long-term effects of a transition to digital distributed ledger, such as changes in supply-chain systems or demand effects.

This detailed analytical framework offers a transparent and flexible approach for analysis of digital distributed ledger integration into customs procedures and allows experimentation with a range of reasonable parameters to estimate the economic effects of incorporating the digital distributed ledger in the United States. The simulation technique utilized a Monte Carlo environment to provide a distribution of possible outcomes for one shipment, including costs and benefits.

7.2.1. Costs vary across risk tiers

In our modeling framework, data sharing costs depend on the risk tier, with higher risk shipments incurring higher costs and lower risk shipments incurring lower costs. High risk shipments include first-time sellers or importers or a shipment that could be classified as high risk based on the product or country of origin. High risk shipments are more likely to incur longer dwell times in addition to the cost requirements of proof of work, proof of stake, and proof of authority differentiation, and so on. Medium risk shipments include repeat sellers or importers or those classified as medium risk based on the product or country of origin. Low risk shipments might include members of CTPAT or the "trusted seller program," or those classified as low risk based on the product or country of origin. There are incentives, therefore, for the seller to be designated in the low risk tier.

Cost structures are based on the incentives to share data, as well as which types of digital distributed ledger are feasible for private sector incorporation into a public digital distributed ledger. A tiered structure is utilized to provide an incentive for stakeholders to share data and achieve a lower landed cost under digital distributed ledger. That additional cost will factor into the landed cost per unit. In the digital distributed ledger scenario, the probability that CBP will seize a shipment with incomplete data is higher than under the status quo, which, in turn, makes the cost to non-cooperation, on average, higher than cooperation. Costs in the digital distributed ledger risk model are also based on the division of data sharing costs, including monitoring, between the public and private sector. The landed cost per unit incorporates the per unit cost, freight cost (shipping), customs duties, overhead (labor), technology (ACE or digital distributed ledger), and risk. Risk includes the cost of dwell time, or the probability that a shipment will be held by an importing agency. Landed costs could be divided among CBP/importing agencies on the monitoring side of technology, and then among sellers, marketplace, 3rd party sellers, other intermediaries,

and brokers. In the risk model, these parties are considered one entity, or the "stakeholder". A higher probability of import seizure or dwell time means higher landed costs for non-cooperating stakeholders compared to the status quo.

As a result of this cost structure, cooperation in digital distributed ledger technology can lead to overall efficiency gains after the initial investment (costs to implementation). Intermediaries will receive faster clearance and increased competitiveness, along with a better reputation for data sharing as a low-risk option. Sellers will likely see faster deliveries and therefore better customer satisfaction. Non-cooperation in e-commerce integration may not lead to any benefits on the business side, but intermediaries could experience increased risk and lower competitiveness with those intermediaries that do participate, and sellers may experience potential revenue loss.

7.2.2. Model parameters

Moving from the status quo to a digital distributed ledger will change the incentives for data sharing, which, in turn will have implications for dwell time, labor costs, and technology costs.

Many of the key data parameters and assumptions are drawn from publicly available U.S. government sources or previous studies on the costs and benefits of digital distributed ledger. The main model inputs from the user include the type of shipment, the number of units, and the customs value of the shipment. The type refers to the risk level of the entry: low risk, medium risk, or high risk. This can be exogenously determined by CBP or other relevant agencies. The number of units and customs value are used to calculate the landed cost per unit of the shipment before and after the incorporation of digital distributed ledger.

The model incorporates key inputs on costs and delays, and offers a flexible modeling approach. The economic effects of moving to a digital distributed ledger environment depend on the set of these inputs:

1. **Stakeholder share of digital distributed ledger cost**: the share of the average cost of digital distributed ledger per transaction that will be borne by the stakeholders
2. **CBP share of digital distributed ledger cost**: the share of the average cost of digital distributed ledger per transaction that will be borne by CBP or other relevant agencies [1]
3. **Digital distributed ledger costs per transaction**: the cost per shipment for using digital distributed ledger including initial onboarding costs, maintenance, cloud-technology, and monitoring

[1] Regarding cost, broad DLT based ICT infrastructures likely provide affordable solutions to CBP and stakeholders (e.g., Amazon's Quantum Ledger Database, DL-as-a-service deployed over cloud based ICT environment).

4. **Total freight costs**: the physical cost of shipping.
5. **Customs duties**: the average customs duties paid by importers
6. **Hours worked status quo**: the number of hours that it takes in the current system to share data by all stakeholders (including sellers, intermediaries, marketplace, brokers, etc.)
7. **Percentage of hours worked with digital distributed ledger**: the number of remaining hours that will be worked under digital distributed ledger to share data by all stakeholders
8. **Hourly payments to wages and salaries**: the dollar value of payments to wages and salaries per hour
9. **Import charges per day**: the charges per day if there is dwell time for a shipment
10. **Cost of ACE/legacy participation**: the cost per shipment for using the ACE system (or other technologies associated with the legacy environment)
11. **Probability of data sharing**: the probability of CBP not having sufficient data to verify that the shipment is legal and safe for speedy entry
12. **Importation delays**: If the data is not shared initially (CBP does not have sufficient data for speedy entry), then this is the probability distribution of the number of days that the shipment could dwell at the time of importation

These user-chosen parameters are described in Table 7.1 below.

The probability of not sharing sufficient data in the status quo varies between de minimis shipments and non-de minimis shipments and by risk levels. Those probabilities are:[2]

- Low risk de minimis: 12%
- Medium risk de minimis: 20%
- High risk de minimis: 50%
- Low risk non-de minimis: 4%
- Medium risk non-de minimis: 8%
- High risk non-de minimis: 12.5%

[2]These percentages are derived from existing information from Customs and Border Protection, which found through Operation Mega Flex that 12.5 percent of targeted parcels contain counterfeit goods or contraband (this is our high-risk category). In addition, OECD has estimates on the percentage of counterfeit goods that are de minimis.

Table 7.1: Key model inputs.

	Low Risk Tier		Medium Risk Tier		High Risk Tier		Source
	DMT	Non-DMT	DMT	Non-DMT	DMT	Non-DMT	
Stakeholders Share of Digital distributed ledger (%)	50	50	50	50	50	50	Ernst and Young author's calculations
CBP Share of Digital distributed ledger (%)	50	50	50	50	50	50	Ernst and Young author's calculations
Digital distributed ledger costs per transaction (low estimate)	$0.47	$0.47	$0.79	$0.79	$0.85	$0.85	Ernst and Young
Digital distributed ledger costs per transaction (high estimate)	$0.85	$0.85	$1.50	$1.50	$3.50	$3.50	Ernst and Young
Customs duties (average)(%)	0	2.8	0	2.8	0	2.8	USITC DataWeb
Customs duties (stdev)	0	0.5	0	0.5	0	0.5	USITC DataWeb
Hours worked status quo (avg)	1	15	2	25	3	35	Stakeholder engagement
Hours worked status quo (delayed)	5	40	5	50	7	60	Stakeholder engagement
Percentage of hours worked with digital distributed ledger (avg)	40%	50%	40%	50%	40%	50%	IBM
Percentage of hours worked with digital distributed ledger (high)	80%	90%	80%	90%	80%	90%	IBM
Hourly payments to wages and salaries (avg)	$40	$40	$40	$40	$40	$40	IBM
Hourly payments to wages and salaries (high)	$100	$100	$100	$100	$100	$100	IBM
Import charges per day (avg)	$20	$150	$20	$150	$20	$150	TCB
Import charges per day (high)	$80	$400	$80	$400	$80	$400	TCB
Cost of ACE (avg)	$0.60	$0.60	$0.60	$0.60	$0.60	$0.60	Stakeholder engagement
Cost of ACE (high)	$1.60	$1.60	$1.60	$1.60	$1.60	$1.60	Stakeholder engagement

The probability of not sharing sufficient data in the digital distributed ledger environment will be:[3]

- Low risk de minimis: 8%
- Medium risk de minimis: 14%
- High risk de minimis: 35%
- Low risk non-de minimis: 2%
- Medium risk non-de minimis: 5%
- High risk non-de minimis: 9%

When sufficient data are not shared for expedient entry, then there is a probability distribution for importation dwell time. Zero days indicate the package got through customs despite insufficient information and/or counterfeit or illicit product.[4] Otherwise, dwell time refers only to those packages that are not illicit but have not shared sufficient data. Packages that are illicit will be automatically seized in the non-zero dwell time. Importation delays occur if sufficient data is not shared in the status quo, then we assume that importation delays will be as follows:[5]

De minimis:

- 0 days: 54%
- 1 day: 36%
- 5 days: 6%
- 10 days: 4%

Non-de minimis:

- 0 days: 27%
- 1 day: 63%
- 5 days: 6%

[3] There are some estimates on how technology enhancements could streamline data sharing. These are derived and applied across all categories.

[4] It is possible that when sufficient data are not shared, and the dwell time is zero days that the package is not illicit at all. However, if the proportion of those with zero dwell time that are illicit is not heterogeneous across status quo or distributed ledger, then the model findings still apply to illicit shipments.

[5] These percentages are based on a TFA report[40] and stakeholder engagement.

- 10 days: 4%

In the digital distributed ledger environment, if digital distributed ledger could reduce dwell time with better targeting and implementation, importation delays if sufficient data is not shared will be:

De minimis:

- 0 days: 27%
- 1 day: 70%
- 5 days: 3%
- 10 days: <1%

Non-de minimis:

- 0 days: 14%
- 1 day: 84%
- 5 days: 3%
- 10 days: <1%

7.3. Results

We consider six modeling scenarios to illustrate the economic effects of moving to a digital distributed ledger customs environment: a de minimis high risk, medium risk, and low risk shipment; and a non-de minimis high risk, medium risk, and low risk shipment.

The table below reports the estimated effects of moving to a digital distributed ledger environment including probability of illicit shipments, average import delay, the net customs margin, and data sharing costs for cooperators and non-cooperators. The first three columns consider a de minimis shipment across high, medium, and low risk shipments, and the last three columns consider a non-de minimis shipment across risk levels.

The de minimis scenarios is a shipment of 20 units at a total customs value of $500, and the non-de minimis scenarios is a shipment of 40,000 units with a customs value of $10,000. Moving to a digital distributed ledger environment results in lower probability of illicit shipments coming through across the board, with a larger decline in high risk de minimis shipments. The average import delay falls for all shipments, across risk tiers and for both de

Table 7.2: Estimated effects of moving to a digital distributed ledger environment.

	De minimis shipment			Non-de minimis shipment		
Risk Level	High	Medium	Low	High	Medium	Low
Probability of illicit shipments coming through undetected (percentage point change)	-17.4	-7.3	-3.9	-2.0	-0.9	-0.8
Average import delay (% change)	-44.5	-42.1	-36.8	-49.2	-48.7	-42.7
Net customs margin (% change)	-44.3	-40.0	-33.4	-48.2	-51.3	-41.3
Cost to data sharing for cooperating stakeholders per unit (% change)	-11.5	-8.4	-4.5	-4.6	-3.4	-2.2
Cost to data sharing for non-cooperating stakeholders per unit (% change)	-29.4	-28.1	-25.8	-9.7	-8.1	-6.0

Note: The de minimis shipment considered here is 20 units at a total customs value of $500, and the non-de minimis shipment is 40,000 units with a customs value of $10,000.

minimis and non de minimis, with the largest decline in delay for high risk non-de minimis. The net customs margin, calculated as the customs charges per day per unit of the shipment, for example, if the shipment is illicit and held and customs, shrinks across the board, with larger declines for the non-de minimis shipments, especially medium risk shipments. Costs to data sharing decline across the board as well, with larger cost savings for de minimis shipments.

Focusing on the results for a high risk de minimis shipment, moving to a digital distributed ledger environment is estimated to have the following potential effects: 1) the probability of illicit shipments declines the most out of any scenario presented; 2) the average import delay decreases by almost half; 3) the net customs margin, reflecting deadweight loss and consumer/producer surplus, decreases from $0.60 to $0.33 (a 44.3 percent decrease); 4) the cost to data sharing for cooperating stakeholders declines slightly less than non-cooperating stakeholders, reflecting a trade-off between deadweight loss and the relative cost of non-cooperation; and, 5) the relative cost of non-cooperation decreases. In a comparison of cooperators and non-cooperators, cooperating stakeholders consistently have lower landed costs on average which reflects how cooperators avoid dwell time costs.

Table 7.3: Model results: high risk de minimis.

	Status Quo	Distributed ledger	Absolute difference	Percent change
Probability of illicit shipments coming through undetected	26.9%	9.4%	-17.4 ppt	N/A
Average import delay (days)	0.51	0.29	-0.229	-44.5%
Net customs margin	$0.60	$0.29	$(0.27)	-44.3%
Cost to data sharing for cooperating stakeholders per unit	$31.03	$27.46	$(3.57)	-11.5%
Cost to data sharing for non-cooperating stakeholders per unit	$40.20	$28.38	$(11.82)	-29.4%

Figure 7.1 shows the distribution of landed costs for cooperators and non-cooperators in a digital distributed ledger environment. Non-cooperators in the digital distributed ledger

scenario have higher average costs and greater uncertainty regarding the upper limit of expenses for data sharing. Those who share sufficient data have less uncertainty and lower costs.

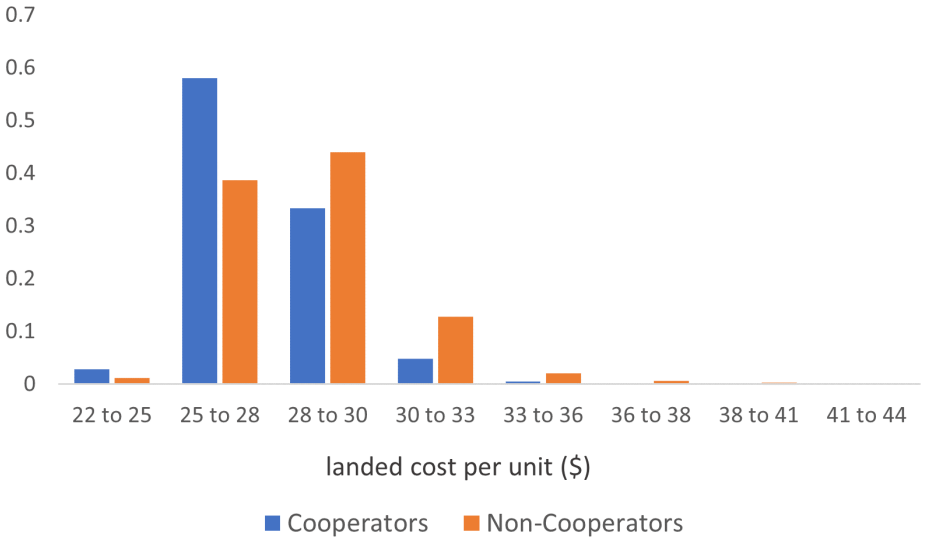


Figure 7.1: The distribution of landed costs per unit in a digital distributed ledger environment for high risk de minimis shipments.
Source: author's calculations.

Figure 7.2 compares the costs for cooperators between the status quo and distributed ledger environments. The results suggest that cooperators will have lower costs under a digital distributed ledger environment.

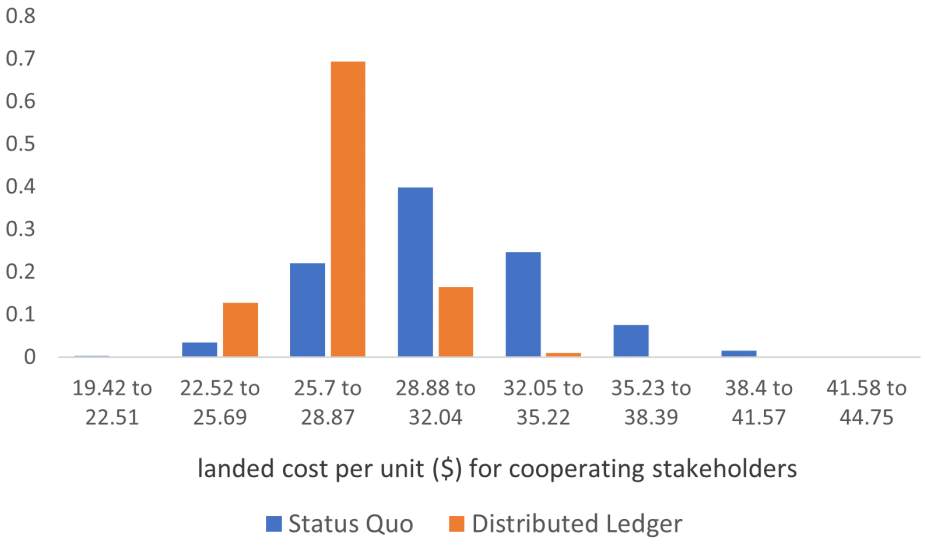


Figure 7.2: Status quo versus digital distributed ledger, cooperator landed cost per unit for high risk de minimis shipments
Source: author's calculations.

With a medium risk de minimis shipment, moving to a digital distributed ledger environment has the following estimated effects: 1) the probability that an illicit shipment comes through undetected declines by over half; 2) the average import delay decreases; 3) the net customs margin decreases; and, 4) we see similar distributional trends to the high-risk scenario.

Table 7.4: Model results: medium risk de minimis.

	Status Quo	Distributed ledger	Absolute difference	Percent change
Probability of illicit shipments coming through undetected	10.9%	3.6%	-7.3 ppt	N/A
Average import delay (days)	0.21	0.12	-0.087	-42.1%
Net customs margin	$0.24	$0.14	$(0.10)	-40.02%
Cost to data sharing for cooperating stakeholders per unit	$29.04	$26.61	$(2.43)	-8.4%
Cost to data sharing for non-cooperating stakeholders per unit	$38.32	$27.57	$(10.76)	-28.1%

With a low risk de minimis shipment, moving to a digital distributed ledger is estimated to have the following effects: 1) the probability that an illicit shipment will come through declines by two-thirds; 2) the average import delay declines; 3) the net customs margin, decreases; and, 4) the relative cost of being a non-cooperator under digital distributed ledger is lower compared to the status quo. We also find similar distributional trends related to the high- and medium-risk de minimis scenarios, albeit with less uncertainty for both cooperators and non-cooperators.

Table 7.5: Model results: low risk de minimis.

	Status Quo	Distributed ledger	Absolute difference	Percent change
Probability of illicit shipments coming through undetected	6.1%	2.2%	-3.9 ppt	N/A
Average import delay (days)	0.12	0.07	-0.043	-36.8%
Net customs margin	$0.13	$0.09	$(0.04)	-33.38%
Cost to data sharing for cooperating stakeholders per unit	$27.03	$25.81	$(1.22)	-4.5%
Cost to data sharing for non-cooperating stakeholders per unit	$36.21	$26.87	$(9.35)	-25.8%

The effects are similar, but concentrated in different kinds of savings, for high risk non-de minimis shipments: 1) the probability that an illicit shipment gets through declines; 2) the average import delay and net customs margin decline; and, 3) The relative cost of non-cooperation was 1.09 and under the digital distributed ledger will be 1.03.

Under a digital distributed ledger environment, CBP is more likely to identify non-cooperators (the share of zero dwell time decreases). Further, CBP is expected to more quickly process seized shipments from non-cooperators (the share of dwell times of 2 or more days decreases) (Figure 7.3). Figure 7.4 shows comparable results to the de minimis scenario with

Table 7.6: Model results: high risk non-de minimis.

	Status Quo	Distributed ledger	Absolute difference	Percent change
Probability of illicit shipments coming through undetected	3.1%	1.1%	-2.0 ppt	N/A
Average import delay (days)	0.18	0.09	-0.087	-49.2%
Net customs margin	$0.0007	$0.0003	$(0.00)	-48.21%
Cost to data sharing for cooperating stakeholders per unit	$0.39	$0.37	$(0.02)	-4.6%
Cost to data sharing for non-cooperating stakeholders per unit	$0.42	$0.38	$(0.04)	-9.7%

landed costs per unit in the digital distributed ledger environment, albeit with less uncertainty.

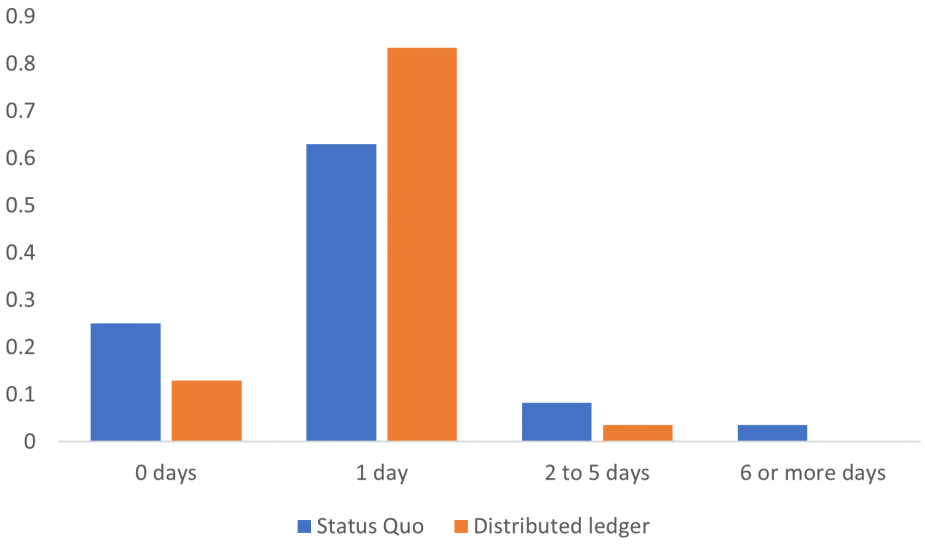


Figure 7.3: Distribution of dwell times for non-cooperators for high risk non-de minimis shipments.
Source: author's calculations.

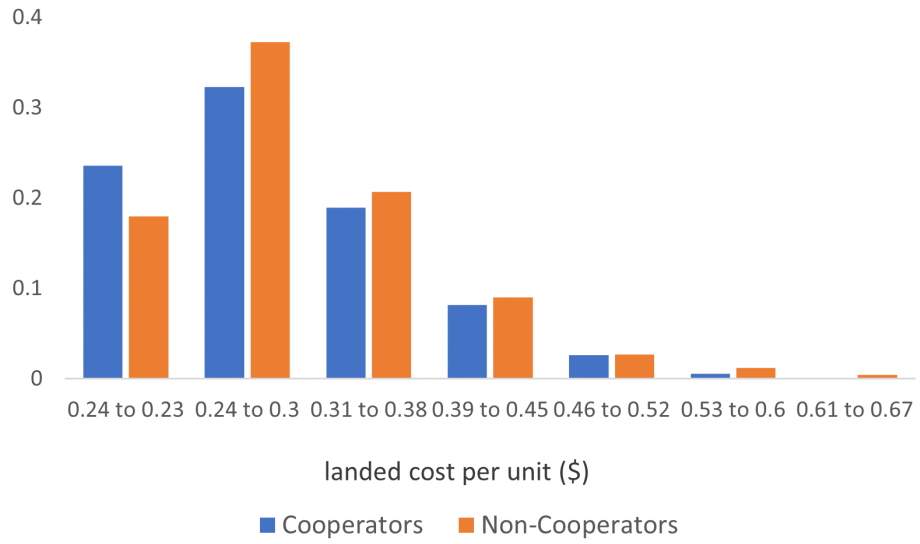


Figure 7.4: The distribution of landed costs per unit in a digital distributed ledger environment for high risk non-de minimis shipments.
Source: author's calculations.

Focusing on a medium risk non-de minimis shipments, moving to a digital distributed ledger will have the following effects: 1) the probability that illicit shipments will get through declines; 2) the average import delay decreases by half; 3) the average customs margin decreases by over half; and, 4) the cost to data sharing for cooperating stakeholders declines, and for non-cooperating stakeholders declines by slightly more. The distributions of costs are like the high-risk scenario.

Table 7.7: Model results: medium risk non-de minimis.

	Status Quo	Distributed ledger	Absolute difference	Percent change
Probability of illicit shipments coming through undetected	2.0%	1.1%	-0.9 ppt	N/A
Average import delay (days)	0.11	0.05	-0.051	-48.7%
Net customs margin	$0.0004	$0.0002	$(0.00)	-51.26%
Cost to data sharing for cooperating stakeholders per unit	$0.37	$0.36	$(0.01)	-3.4%
Cost to data sharing for non-cooperating stakeholders per unit	$0.40	$0.37	$(0.03)	-8.1%

Finally, for a low risk non-de minimis shipment, moving to a digital distributed ledger will have the following effects: 1) the probability that illicit parcels will get through declines; 2) the average import delay declines; and, 3) the net customs margin improves by over 41 percent.

Another distributional effect we explored is the extent to which high or low digital distributed ledger costs could be driving the distributions of the landed costs for cooperat-

Table 7.8: Model results: low risk non-de minimis.

	Status Quo	Distributed ledger	Absolute difference	Percent change
Probability of illicit shipments coming through undetected	1.2%	0.4%	-0.8 ppt	N/A
Average import delay (days)	0.05	0.03	-0.021	-42.7%
Net customs margin	$0.0002	$0.0001	$(0.00)	-41.32%
Cost to data sharing for cooperating stakeholders per unit	$0.37	$0.36	$(0.01)	-2.2%
Cost to data sharing for non-cooperating stakeholders per unit	$0.39	$0.37	$(0.02)	-6.0%

ing stakeholders. In a low risk non-de minimis setting where the per unit customs value is $20.00, the cost of digital distributed ledger does not seem to be a main driving force behind the differences in the landed costs.

Figure 7.5 shows that the distribution of landed costs per unit for a distributed ledger environment for low risk, non-de minimis shipments are nearly identical across distributed ledger technology costs. In other words, the digital distributed ledger is not a key driver of the variation of the landed cost per unit. (The same patterns were found for high risk non-de minimis, not shown here.)

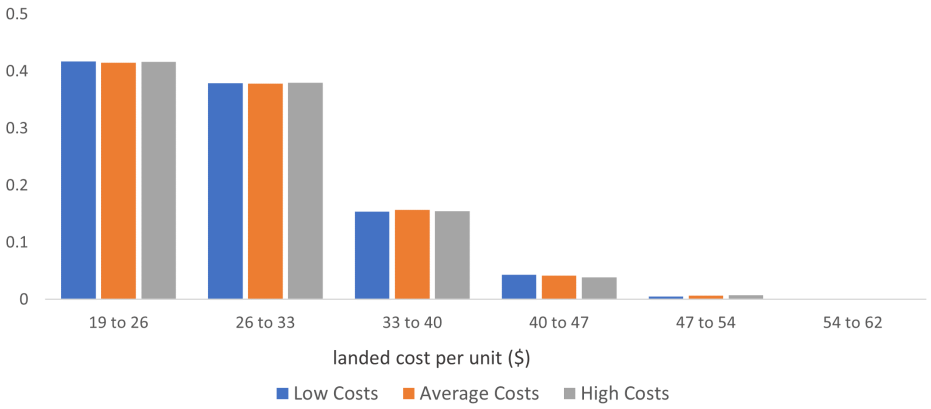


Figure 7.5: The distribution of landed costs per unit for digital distributed ledger for low risk non-de minimis shipments.
Source: author's calculations.

One might expect digital distributed ledger costs to have a non-trivial effect for small unit, small value shipments; however, for the vast majority of shipments, the implementation and utilization of digital distributed ledger customs environment does not affect landed cost per unit. Instead, other factors are more important such as dwell time (which in turn is driven by risk and cooperation) and labor costs.

7.4. Summary of key findings

Chapter 7 of this report presents a detailed analytical approach to examine the economic effects of moving to a digital distributed ledger customs environment. Leveraging digital distributed ledger technology solutions in a customs environment is expected to have the following main economic effects (for both de minimis and non-de minimis shipments, and across all risk tiers):

1. The number of shipments where the stakeholders cooperate will increase.
2. The probability that CBP and other importing agencies will obtain sufficient data for expedient entry increases.
3. The number of shipments where stakeholders do not share sufficient data will decrease.
4. Digital distributed ledger technology costs do not drive the differences in landed costs.
5. The economic efficiency of the importing process improves with the digital distributed ledger customs environment. This encompasses the efficiency effects for the consumer, the importer, and other stakeholders.

The risk model captures the effects on the net customs margin, which drives a wedge between the price the importer pays and the price the foreign seller receives. This wedge, referred to here as a net customs margin, has a similar effect to that of a tax, except the government does not collect revenue, and hence the margin can be thought of as a pure deadweight loss to the economy. In theory, the costs of the deadweight loss and the associated inefficiencies are borne by the foreign seller, the U.S. importer, U.S. consumers and businesses, and other stakeholders. In practice, the actual distribution of the costs depends on marketplace characteristics and the degree of competition.

Figure 7.6 illustrates the economic effects of the margin, and as the net customs margin decreases, the deadweight loss shrinks and there is an efficiency gain. The dashed red area is the initial deadweight loss, while the blue and red area is the new deadweight loss. The difference between the two areas is the efficiency gain to the economy.

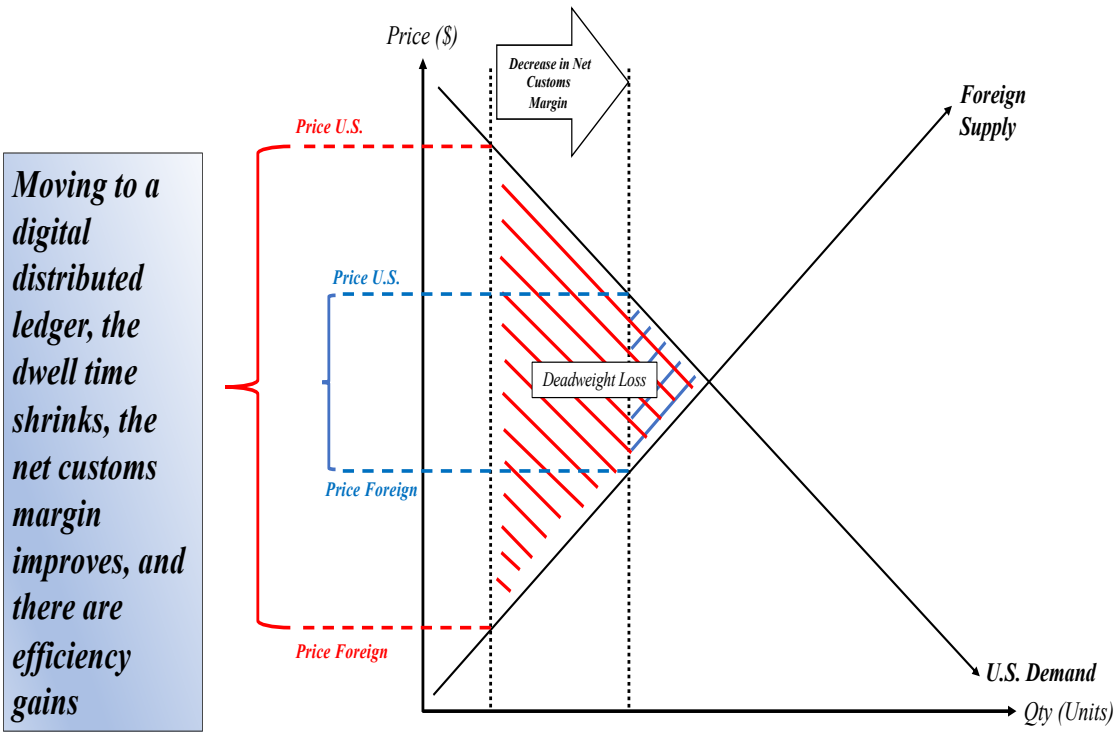


Figure 7.6: The net customs margin and deadweight loss.

A second-order result is that the trade-off between the net customs margin and the relative cost of non-cooperation has changed. In most cases, while the absolute cost to being a non-cooperator in the digital distributed ledger environment has increased, the relative cost has decreased, and this is because dwell time has been reduced. The dwell time effect is directly reflected in the net customs margin. The share of imports with a higher dwell time due to insufficient data sharing has gone down.

This trade-off highlights the importance of enforcement. The lower the dwell time, the greater the efficiency gains, but the disincentives for cheating have been hindered. In light of this trade-off, CBP and other importing agencies may consider legal avenues or other enforcement mechanisms to capture the gains in efficiency while avoiding the trade-off of non-cooperation.

7.4.1. Potential extensions of the model

This model could be expanded to include more sophisticated simulation techniques with behavioral parameters to estimate the overall effects on the economy with a dollar amount. With more data, more sophisticated parameters and distributions can be applied to the inputs. Another way to expand this model within the Monte Carlo environment is to break out the costs to cooperation and non-cooperation by mode of transportation.

Different modes of transportation will experience higher or lower costs depending on associated risk. If risk levels do not change when moving to the digital distributed ledger, then the cost savings ($) will be larger for modes of transportation that traditionally have experienced longer dwell times.[6]

7.5. Barriers to e-commerce data cooperation

7.5.1. Potential barriers

A barrier to e-commerce data cooperation in the digital distributed ledger environment is the up-front implementation costs and day to day monitoring costs to incorporating the digital distributed ledger into data sharing. Large firms, which tend to have larger administrative budgets and operate at greater economies of scale will have lower costs on the margin than small or medium sized firms. There are, however, some private sector cost mitigation strategies (outside the scope of the digital distributed ledger risk model) and we discuss them below.

7.5.2. Private sector cost mitigation strategies

Large firms will likely be able to sell or give access to their own digital distributed ledger technologies to smaller companies (SME's). Marketplaces with a lot of small sellers will have their sellers send data through the marketplace's distributed ledgers, lowering the costs for SME's while simultaneously allowing marketplaces and large sellers continue to have wider access to their platforms.

Artificial intelligence (AI) for product classification may be another way that the private sector can lower the average costs of digital distributed ledger. Especially when product classification, like HTS codes, is a requirement, AI may be able to lower the costs to sending that data in the distributed ledger. Linked data from webpages can automatically draw different attributes of the product, even if the data is unstructured. For example, AI can be employed by marketplaces to automatically draw product information from the webpage when the product is posted. This lowers the cost of cooperation in the digital distributed ledger, allows for verifiable data by other parties, and streamlines one part of the entry process.

7.5.3. Trusted seller program

In a so-called trusted seller program, there would be a cost incentive for consistently sending data. A trusted seller program may also have some economic rationale in the digital distributed ledger environment. Incentives for cooperation are important for new govern-

[6] Note, this assessment is based on the range of dwell times that an importer could experience in the risk model.[40]

ment programs involving the private sector. In addition to negative incentives for non-cooperation (dwell time, fines, losing revenue), positive incentives for cooperation could include a trusted seller program.

A trusted seller program would allow companies that may be in a higher risk tier to move into a lower risk tier based on history of sufficient data sharing and cooperation. This would lower the price of digital distributed ledger monitoring for that company and may streamline their entry process. Having positive incentives for moving away from higher risk tiers would encourage sellers and marketplaces to consistently share data.

8

Data sharing and postal network

8.1. Background and stakeholders

Significant percentage of cross-border e-commerce parcels are shipped via global postal network. The volume has been steadily growing. Several federal agencies and other entities including USPS have responsibility for the movement of inbound international mail into the U.S. USPS has reported a 54 % increase in inbound international mail volume from fiscal year 2012 to fiscal year 2016. International parcel post volumes reached 0.18 billion items in 2018, an increase of 29.7% compared to 2017.

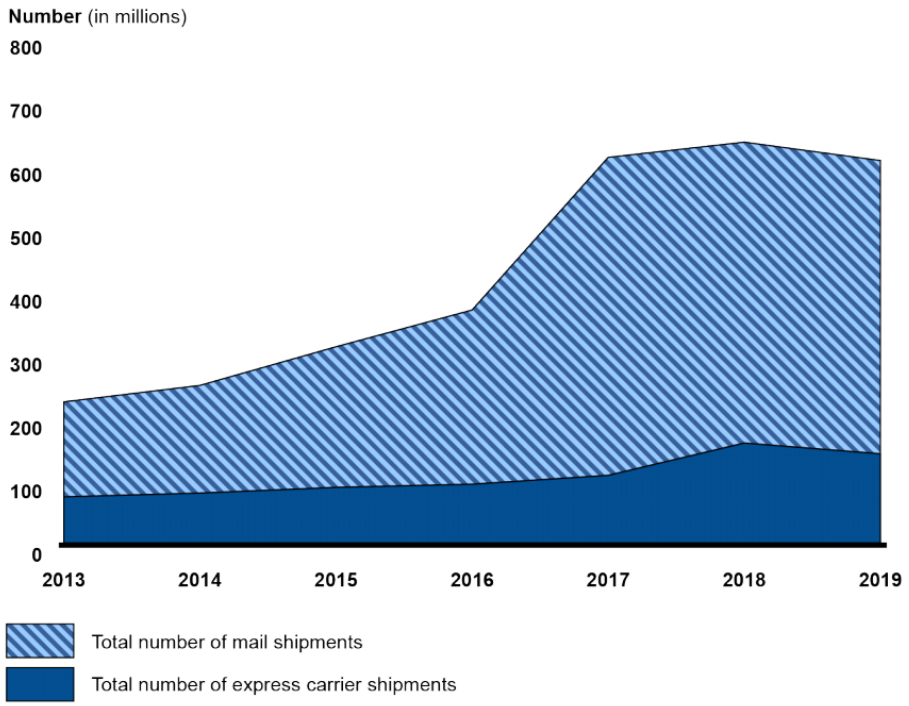


Figure 8.1: Number of small packages sent to the U.S. through international mail and express carriers 2013-2019 (source: GAO report based on CBP statistics [23])).

After arrival, USPS and CBP work together to process and inspect mail (see Appendix K for the process). Operations of international mail are governed by the Universal Postal Union (UPU), a UN specialized agency, under the Universal Postal Convention. The union has over 190 member countries. The State Department represents the U.S. along with USPS, at the UPU Congress and other UPU meetings to decide policies and requirements of mail shipping. USPS is the designated postal operator in the U.S. It accepts and delivers inbound international mail on behalf of designated postal operators in other countries.

8.2. Challenges

USPS and CBP have been facing challenges to process and handle inbound international parcels, mostly deliveries of e-commerce transactions. In addition to challenges related to the rapid growth of mail volume, availability and quality of data related to the contents of inbound parcels have been identified as major problems that need to be tackled. In particular, there is a lack of data for small packages that are below the U.S. de minimis threshold. This situation makes it very difficult for CBP and the partner agencies to carry out risk assessments that depend on advanced, adequate and accurate information to determine risk scores. In the cases where electronic advanced data related to mail shipping is received, the data may be of low quality for targeting purposes.

Regarding electronic advanced data, USPS depends on foreign postal operators to collect

and provide the data voluntarily or based on mutual agreement.

According to USPS and GAO report [20], USPS received EAD for roughly half of all inbound international mail (excluding letters and military/diplomatic mail) – data of March 2017. In case EAD is provided based on mutual data sharing agreements with foreign postal operators, the data may not cover all the products, or all the inbound mail. Among several reasons mentioned by USPS according to the GAO report include, lack of technology infrastructure by some foreign postal operators to collect and transfer EAD; availability of EAD on certain types of mail; and prohibitive or unjustified cost for collecting and transmitting EAD in case of small amount of mail. In addition, foreign postal operators may not share the same priority concerns for importation as CBP, which hampers efforts to make EAD available. Due to these reasons and lack of control over data collection process, even EAD is available, in general, data quality is poor.

8.3. Efforts to address the challenges

UPU has taken steps to ensure that member countries have the tools to address the e-commerce challenges including EAD capabilities. In 2017, the Regulations to the UPU Convention were changed to require that mail parcels containing restricted goods subject to specific import control by authorities must provide EAD using the appropriate UPU Customs declaration form (see Appendix C) and include unique item identifier. The amended UPU Acts also make a unique item identifier (barcode) mandatory for all items containing goods. In addition, there have been efforts to unify tracking labels for parcels shipped over express carriers and postal network, for instance by adopting GS1 SSCC.

To standardize the exchange and use of EAD between Posts and Customs, UPU has worked jointly with the WCO to develop WCO–UPU Electronic Data Interchange (EDI) message standards (e.g., CUSITM, CUSRSP) and publish joint WCO–UPU guidelines on EAD collection and operations (Postal Customs Guide, Guidelines on EAD, and Data Capture Guidelines) [48, 50, 51, 62].

To partner with key stakeholders in cross-border e-commerce delivery, UPU has collaborated with IATA (International Air Transport Association) and ICAO (International Civil Aviation Organization) to develop a postal data model that provides EAD to appropriate stakeholders (see Appendix I) for a high level view [26, 27].

UPU-WCO framework [50] does include a feedback mechanism designed to improve data quality from Customs on electronic data. When CN 22/23 (see Appendix C) data is exchanged in electronic form, the receiving Post should have regular discussions with Customs with regard to the quality of the data, and obtain the feedback that Customs would seek to provide to senders regarding data quality. The receiving Post should then provide these observations to the sender Post(s), to try and increase the quality of the electronic data.

There are options identified by USPS and State Department to expand collection of EAD

from foreign postal operators. One of them is to strategically pursue additional bilateral agreements with foreign postal operators regarding collection of additional EAD. This approach may have limitations for aforementioned reasons. Another direction is to work with UPU to develop on agenda for all the member countries to uniformly adopt and meet EAD standards and requirements. However, such efforts may take a long time to have expected results because many foreign postal operators may either lack infrastructure and capacity to collect EAD or do not have the will to assign this function as a high priority. Other regulatory or legal options by the U.S. may cause disruption to mail exchanges between U.S. and other countries.

Integrating the digital distributed ledger with the postal network.

Reports indicate that packages shipped through the postal network incur fewer examinations than packages going through other carriers. From an economic perspective, the digital distributed ledger could not only streamline the postal process like other modes of transportation, but also lower the cost to implementation on the postal side. In this way, targeting in the postal environment as well as other environments could be improved.

8.4. Data sharing implications for postal delivery

The data sharing models described in chapter 5 can be applied to postal delivery of e-commerce parcels.Extension of the stakeholder community (from EAD collection point of view),to e-commerce intermediaries and sellers would require platforms, marketplaces, and fulfillment centers to bear responsibilities of data sharing. Such an approach could mitigate some of the data challenges that the Customs authorities are facing.

E-commerce intermediaries operate in a data rich environment. For goods contained in an inbound parcel, risk assessment and targeting would be more effective if Customs can link the postal shipping identifier to the corresponding e-commerce transaction where data such as seller, details of product listing (e.g., descriptions, specifications, product pictures, consumer feedback) is available to determine the risk.

In many cases, if purchased goods from a marketplace or platform are shipped with postal service, the intermediary often has the postal tracking number. There is a reverse flow of postal shipping data including tracking number from fulfillment center or distribution center back to the intermediary. This allows the marketplace or platform to track if the goods have been delivered. For instance, a platform may only allow a buyer to post a comment or write a review if the goods have been received.

Different from the situation of foreign postal operators, e-commerce intermediaries often have the technology infrastructure to share data with the Customs authorities. Data quality challenges can be further addressed by technologies such as AI and big data analytics where automated approach could be applied to data collected from the e-commerce postal stakeholders. When stakeholders residing in foreign countries (e.g., marketplaces or distribution centers) conduct business with U.S. e-commerce customers, regulatory changes, policy

and administrative guidelines, or mutual agreements between countries may be necessary to make data sharing possible.

9

Monitoring and evaluation

In this chapter, we will discuss how data sharing options could be monitored and possible approaches to evaluate their effectiveness.

Monitoring and evaluation can provide data to policy and decision makers regarding effectiveness of implemented data sharing programs. The data could help to shape further policy changes and ensure development of evidence based data sharing programs.

Currently, private sector e-commerce stakeholders including platforms and marketplaces have developed their own metrics to measure effectiveness of practices designed to address issues such as IPR protection and fight against counterfeit products. For instance, Amazon reports that more than 99% of all Amazon store page views by the customers landed on pages for which no notice of potential IPR infringement had been received. Alibaba applies a different measurement in its report that 96% of proactive takedowns were removed before a single sale [63].

In the report issued January 2020 by Office of Strategy, Policy & Plans, CBP has laid down a set of best practice guidelines for marketplaces. Having recommendations on how to assess and measure effectiveness of private sector implementations of best practices as well would help to promote standardization and uniformity so that compliance levels and performance could be compared across platforms and intermediaries. With uniform and commonly accepted measurements, it would be plausible to benchmark performance of private sector efforts and develop better ways to allocate targeting resources of Customs.

Given that advance data sharing would allow the Customs authorities to link parcel shipments with marketplaces, sellers' online stores, and products listed on marketplaces, Customs authorities can correlate measurements reported from platforms with their own targeting models and seizure data.

With additional data shared with the Customs authorities from intermediaries, enhanced targeting models could be developed that incorporate the data into the targeting algo-

rithms for determining risk. For instance, based on data shared from intermediaries, the models could assess likelihood of mis-classification, satisfaction of PGA data requirements, IPR infringement, etc.

To track performance of the models, a baseline could be established, for instance a baseline seizure rate based on random sampling and examination of items. The baseline seizure rate can be compared against the seizure rate that results from the new targeting models. Under this process, the models can be continuously updated and improved over time. The same principle of measurements can be applied to any trusted sellers/vendors program on data sharing.

In addition to seizure and targeting performance, financial and human labor costs are other factors that can be measured, for instance, financial cost to collect, process and analyze newly obtained datasets from the intermediaries and private sector stakeholders, impacts of labor cost to the Customs authorities due to improved targeting capability and risk management. Private sector costs would include investment to implement and maintain data sharing processes with the Customs authorities.

10

Conclusion

The e-commerce marketplace has spurred increased competition, lower prices, and more variety. By offering ease of access and more ways by which transactions can be completed, e-commerce is fast becoming the platform that consumers and businesses use to access global markets. Raising the de minimis threshold has increased the number of duty free eligible imports, lowered costs to importers, and simplified the import process for low valued cross-border shipments. As such, the increased volume of de minimis packages that do not require a full set of data to be filed with CBP has presented challenges along with the overall increase in small, non-containerized trade facilitated by e-commerce.

There are specific gaps and challenges for CBP to obtain complete and accurate data of cross-border e-commerce shipments, such as: (i) data held by intermediaries; (ii) seller or intermediary without physical presence; (iii) fragmented data; and (iv) low data quality. All result in insufficient data for the Customs authorities and partner government agencies to achieve efficient processing of cross-border e-commerce import transactions, and shipments.

In this report, we have identified options to address e-commerce data challenges.

One approach to incentivize voluntary compliance and data sharing with the Customs authorities is to develop a new AEO program tailored for cross-border e-commerce environment. Based on the principles of the original AEO framework laid down by the WCO, there are opportunities to develop an e-commerce focused AEO program that establishes and grows partnership between the Customs authorities and e-commerce stakeholders including intermediaries to adopt higher standards of e-commerce functions specifically for solving the challenge of data sharing.

To receive AEO accreditation as trusted intermediaries or trusted online sellers, e-commerce AEO applicants should: (i) demonstrate compliance with the customs requirements regarding e-commerce best practice guidelines and recommendations; (ii) maintain data sharing programs at different granularity levels with the Customs authorities and take mea-

sures to ensure data quality and accuracy; (iii) cooperate with other e-commerce intermediaries and stakeholders to enable data sharing within e-commerce to improve security and efficiency of global supply chain, and facilitate adoption of open standards for data exchange/data sharing; and (iv) adopt internal process to measure and analyze effectiveness of best practices, and develop further enhancements based on evidence.

An e-commerce AEO program could extend to the intermediaries and/or online sellers that have no physical presence in the U.S. but have U.S. customers. These include, platforms or marketplaces operated by foreign entities, foreign warehouses and distribution centers, and oversea sellers who use e-commerce environment to sell merchandise to the U.S. consumers. Plurilateral collaborations and agreements are important aspects of an e-commerce AEO program that expands to the foreign e-commerce stakeholders.

An AEO program should take into account the challenges that MSMEs are facing. For instance, a concern is that large e-commerce intermediaries or sellers may have advantages over MSMEs to implement and adopt AEO requirements and standards as they already have invested in related programs and technologies. The additional benefits from gaining AEO status by the large intermediaries could have significant impacts and consequences for the smaller stakeholders in the e-commerce environment. This challenge could be addressed if the AEO program is designed from the beginning with the situations and needs of MSMEs being taken into account.

Many countries enforce some form of localization laws to restrict data flows across borders, which pose challenges to data sharing. Regulations limiting cross-border data flows and requiring local data storage are examples of localization requirements that prohibit companies from exporting or sharing data outside a country. Such restrictions can limit the effectiveness of any data sharing program for e-commerce. Moving forward, a key issue for policymakers would be designing effective e-commerce AEO programs, which requires data sharing in the face of emerging localization laws around the world.

There have been growing efforts in the private sector to construct federated data environments for e-commerce that build on top of open and de facto standards. These efforts include different collaboration models (e.g., federated data infrastructures, data sharing oriented consortia and alliances, data hubs), and aim at forging communities of e-commerce stakeholders and developing standards and guidelines for data exchange and data sharing. If successful, a federated ICT infrastructure supported by its participating organizations will be able to provide a set of standardized e-commerce data sharing services to its stakeholders, augmenting both business activities of the private sector and governance procedures of the public sector.

Federated data platforms may consist of the following components: (i) a federated ICT infrastructure instead of a centralized infrastructure controlled and managed by a dominant player in e-commerce; (ii) a network of digital services that creates a community for data exchanges and data sharing to meet the needs of stakeholders; (iii) adoption of existing, open and de facto standards for data exchange and data sharing; and (iv) means of piggy backing by the government authorities on data exchanged over the federated infrastruc-

ture. Customs and partner government agencies can receive data from the federated infrastructure through binding the authority data model with the e-commerce data model specified by the data governance body of the federation environment. Standards play critical roles in facilitating data exchanges in all the data flow scenarios including B2B (business to business), B2G (business to government), and G2G (government to government).

In the report, we further advocate that technologies can be applied to augment and enhance data sharing among e-commerce stakeholders.

Technologies such as AI/ML, digital distributed ledgers, big e-commerce data, and linked data-related technologies could bring benefits to data sharing including improved data quality, reduced labor cost for data administration and management. increased automation, enriched data sources, enhanced data interoperability, and improved accountability.

Customs and partner government agencies rely on accurate classification of imported products for customs functionalities such as determination of admissibility of the imported goods; qualification for preferential or special treatment; risk-based targeting to identify harmful, or infringing products, calculation of duties, taxes and fees; determination of permits, license and certificates required, and collection of trade statistics.

Platforms and marketplaces are sitting on top of a rich and vast amount of data created by both the sellers and consumers. These include product data uploaded by the sellers such as product descriptions, specification, and pictures; as well as data contributed from consumers including comments, questions/answers regarding the products (e.g., questions related to product functionality, usage, components, materials). The current abundance of e-commence data and advanced machine learning techniques provide an opportunity for cross-border e-commerce stakeholders to apply automated approach of classification that can more accurately categorize the products and determine risk levels. As such, AI based auto-classification tools could improve capabilities of e-commerce intermediaries to detect high risk products and determine if a product belongs to controlled categories with PGA data requirements. Decisions by e-commerce stakeholders will become increasingly automated by adopting such technologies.

DLT can enhance and augment a federated data platform, which by design is based on the concept of decentralization and cooperation of nodes that are owned or operated by a community of stakeholders. A federated data infrastructure does not necessarily depend on the application of DLT. However, a hybrid design that integrates DLT with other technology components such as cloud based infrastructures and mobile devices could yield beneficial results.

One benefit that DLT could bring, after broad adoption, is to lower transaction costs and increase transparency, which could benefit MSMEs. In this report, we have provided economic analysis that utilizes a risk-based model to assess the costs and benefits for stakeholders of moving from the current data sharing system to a digital distributed ledger in a customs environment. The model incorporates several key drivers of variation in landed costs including technologies, labor, and dwell time. The analysis differentiates between

stakeholders who share sufficient data for expedient entry and those who do not share sufficient data for expedient entry.

Using this detailed analytical approach, we find that leveraging advanced data sharing options like digital distributed ledger technology will have the following effects:

- The number of shipments where the stakeholders cooperate will increase.
- The probability that CBP and other importing agencies will obtain sufficient data for expedited entry increases.
- The number of shipments where stakeholders do not share sufficient data will decrease.
- Digital distributed ledger technology costs do not drive the differences in landed costs.
- The economic efficiency of the importing process improves with the digital distributed ledger customs environment. This encompasses the efficiency effects for the consumer, the importer, and other stakeholders.

In context of big e-commerce data, linked open data is an approach to capture data from original and heterogeneous data resources, and connect the data as a database of knowledge for analysis using well defined standards of semantics. Linked open data can be applied to construct knowledge base of e-commerce for accurate and effective risk analysis. One specific use case of linked data related to product information is the possibility to construct decentralized e-commerce product data catalogs, which enables the reality of a web of linked product information. Such data sources if linked to e-commerce shipping data can greatly enhance the capabilities for identifying high-risk imports and carrying out risk management more effectively.

Linked data standards and technologies create opportunities to construct knowledge-based databases for e-commerce from public data sources (both structured data and unstructured data). Advanced data sharing would allow Customs to link parcel shipments with marketplaces, sellers' online stores, and products listed on marketplaces. Advanced data sharing would further enable CBP to correlate measurements reported from e-commerce platforms under various data sharing options with CBP's own targeting models and seizure data.

The all-stakeholder data sharing models can also be applied to postal delivery of e-commerce packages and parcels. It extends the stakeholder community from international mail EAD collection point of view to encompass broadened e-commerce intermediaries as well as online sellers, by requiring platforms, marketplaces, and fulfillment centers to bear responsibilities of data sharing for international mail containing goods. Such an approach could mitigate some of the data challenges that the Customs authorities are facing related to data completeness, data coverage, and data quality of international mail.

Future research and development directions could include: development of concrete proof-of-concept projects to showcase some of the use case scenarios described in this report (e.g., auto-classification of e-commerce product listing for determining PGA data requirements, distributed ledger based claim verification of FDA registration, binding of customs data model with e-commerce data standards in context of distributed ledger based data sharing, evaluation of broad DLT based ICT infrastructures for data sharing such as DL-as-a-service, Amazon's Quantum Ledger Database); (ii) large scale survey of e-commerce stakeholders and intermediaries including marketplaces regarding data sharing and adoption of technologies; and (iii) further impact analysis of e-commerce data sharing encompassing both technical and non-technical areas.

Appendices

A

WCO cross-border e-commerce framework of standards

WCO Cross-Border E-Commerce Framework of Standards (June 2018)

The Framework of Standards is intended to provide global baseline standards to assist Customs and other relevant government agencies in developing E-Commerce strategic and operational frameworks supplemented by action plans and timelines. It provides the standards for the effective management of cross-border E-Commerce from both facilitation and control perspectives.

Standard 1: Legal Framework for Advance Electronic Data

A legal and regulatory framework should be established for requiring advance electronic exchange of data between relevant parties involved in the E-Commerce supply chain, and Customs administrations and other relevant government agencies to enhance facilitation and control measures, taking into account applicable laws, inter alia, those related to competition (anti-trust), and data security, privacy, protection, ownership.

Standard 2: Use of International Standards for Advance Electronic Data

Relevant WCO and other international standards and guidance should be implemented in accordance with national policy, in an effective and harmonised manner, to facilitate the exchange of advance electronic data.

Standard 3: Risk Management for Facilitation and Control

Customs administrations should develop and apply dynamic risk management techniques that are specific to the E-Commerce context to identify shipments that present a risk.

Standard 4: Use of Non-Intrusive Inspection Technologies and Data Analytics

Customs administrations should use data analytics and screening methodologies in conjunction with non-intrusive inspection equipment, across all modes of transportation and operators, as part of risk management, with a view to facilitating cross-border E-Commerce flows and strengthening Customs controls.

Standard 5: Simplified Clearance Procedures

Customs administrations, working in coordination with other relevant government agencies as appropriate, should establish and maintain simplified clearance formalities/procedures utilising pre -arrival processing and risk assessment of cross-border E-Commerce shipments, and procedures for immediate release of low-risk shipments on arrival or departure. Simplified clearance formalities/procedures should include, as appropriate, an account-based system for collecting duties and/or taxes and handling return shipments.

Standard 6: Expanding the Concept of Authorised Economic Operator (AEO) to Cross-Border E-Commerce

Customs administrations should explore the possibilities of applying AEO Programmes and Mutual Recognition Arrangements/Agreements in the context of cross-border E-Commerce, including leveraging the role of intermediaries, to enable Micro, Small and Medium-sized Enterprises (MSMEs) and individuals to fully benefit from the opportunities of crossborder E-Commerce.

Standard 7: Models of Revenue Collection

Customs administrations, working with appropriate agencies or Ministries, should consider applying, as appropriate, various types of models of revenue collection (e.g., vendor, intermediary, buyer or consumer, etc.) for duties and/or taxes. In order to ensure the revenue collection, Customs administrations should offer electronic payment options, provide relevant information online, allow for flexible payment types and ensure fairness and transparency in its processes. Models that are applied should be effective, efficient, scalable, and flexible, supporting various business models and contributing to a level playing field for and among the various E-Commerce stakeholders.

Standard 8: De minimis

When reviewing and/or adjusting de minims thresholds for duties and/or taxes, Governments should make fully informed decisions based on specific national circumstances.

Standard 9: Prevention of Fraud and Illicit Trade

Customs administrations should work with other relevant government agencies to establish procedures for analysis and investigations of illicit cross-border E-Commerce activities with a view to prevent and detect fraud, deter the misuse of E-Commerce channels and disrupt illicit flows.

Standard 10: Inter-agency Cooperation and Information Sharing

Governments should establish cooperation frameworks between and among various national agencies through relevant electronic mechanisms including Single Window, as appropriate, in order to provide cohesive and coordinated response to safety and security risks stemming from cross-border E-Commerce, thus facilitating legitimate trade.

Standard 11: Public-Private Partnerships

Customs administrations should establish and strengthen cooperation partnerships with E-Commerce stakeholders to develop and enhance communication, coordination and collaboration, with an aim to optimise compliance and facilitation.

Standard 12: International Cooperation

Customs administrations should expand Customs cooperation and partnerships to the cross-border E-Commerce environment in order to ensure compliance and facilitation.

Standard 13: Communication, Public Awareness and Outreach

Customs administrations should make consumers, the public and other stakeholders aware of the regulatory requirements, risks and responsibilities associated with cross-border E-Commerce through comprehensive awareness raising, communication, education and outreach programmes.

Standard 14: Mechanism of Measurement

Customs administrations should work with relevant government agencies in close cooperation with E-Commerce stakeholders to accurately capture, measure, analyse and publish cross-border E-Commerce statistics in accordance with international statistical standards and national policy, for informed decision making.

Standard 15: Explore Technological Developments and Innovation

Customs administrations in collaboration with other relevant government agencies, private sector and academia, should explore innovative technological developments and consider whether these developments can contribute to more effective and efficient control and facilitation of crossborder E Commerce.

Source: WCO [57].

B

UPU-WCO CN22/CN23

CN 22

1. Designated operator
2. Gift, Documents, Sale of Goods, Commercial Sample, Returned Goods, Other
3. Quantity and detailed description of contents
4. Net weight
5. Value and currency
6. HS tariff number
7. Country of origin
8. Total weight (in kg)
9. Total value
10. Sender's signature and date

CN 23

1. From: Name, Business, Street, Post code, City, Country
2. To: Name, Business, Street, Post code, City, Country
3. Importer's reference {if any) {tax code/ VAT No. / Importer code) (optional)
4. Importer's telephone / fax / e-mail {if known)

5. Detailed description of contents
6. Quantity
7. Net weight
8. Total gross weight
9. Total value
10. Category of item: Gift, Documents, Commercial sample, Returned goods, Sale of goods, Other, explanation:
11. Comments:
12. Licence No(s).of licence(s)
13. Certificate
14. Invoice No. of invoice
15. For Commercial items only:
16. HS tariff number
17. Country of origin
18. Date of deposit and office of origin
19. Postal charges/ Fees
20. Date and sender's signature

Source: UPU [49].

C

Example of cross-border e-commerce (B2C, C2C) supply chain key points data elements (February 2019)

Order	Vendor	Consignee	Goods	Price
Number	Trading platform/marketplace Name	Name	Description of Goods	Currency
Date of Order		Address	Seller Article (Item) Number/ Name	Unit Price
		Phone Number	Country of Origin	Total Price
			Weight in Kg	Freight Charges
			Quantity	

Figure C.1: E-commerce data elements.

II

Order Confirmation / Submit shipping information to intermediary

Payment Provider	Vendor	Payer	Payment
Name	Trading platform/marketplace Name	Name	Total Payment
Date of Payment		Means/Method of Payment	Currency
Time of Payment		Phone Number	Price

Figure C.2: E-commerce data elements.

III

Prepare Commercial Documentation for shipping

Number	Date	Name	Consignee	Goods	Fee
Parcel Number	Date of Arrival at Place of Discharge	Name of Logistics Provider	Name	Brief cargo description	Currency
Conveyance Reference Number	Date of shipping	Fulfillment Provider Name	Address	Number of packages	Freight Charges
		Carrier Identification	Phone Number	Total gross weight	Other fees (insurance, etc.)
				Net Weight in Kg	
				Country of Origin	
				Country of departure	
				Type of Package	
				Quantity	

Figure C.3: E-commerce data elements.

IV

Transmit Advance Data

Number	Date	Consignee	Transport	Goods
Parcel Number	Date of Arrival at Place of Discharge	Name	Means of transport	Brief cargo description
Conveyance Reference Number	Date of shipping	Address	Port of entry	Number of packages
B/L Number		Phone Number	Conveyance Reference Number	Total gross weight
				Net Weight in Kg
				Country of Origin
				Country of departure
				Type of Package
				Quantity
				Seller Article (Item) Number(HS Code)

Figure C.4: E-commerce data elements.

V

Transmit Consolidated accounting Data to Customs administrations

Number	Date	Order/Consignor/Consignee	Transport	Goods	Price
Parcel Number	Date of Arrival at Place of Discharge	Name	Means of transport	Seller Article (Item) Number(HS Code)	Currency
Conveyance Reference Number	Date of shipping	Address	Port of entry	Number of packages	Unit Price
B/L Number	Date of Declaration	Phone Number	Conveyance Reference Number	Total gross weight	Total Price
Order Number			Ships/Flight Number	Net Weight in Kg	Freight Charges
			Voyage	Country of Origin	Other fees (insurance, etc.)
				Quantity	

Figure C.5: E-commerce data elements.

				Licence	
				Certificate	
				Invoice (with reference number)	

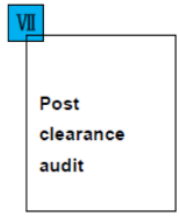
Figure C.6: E-commerce data elements.

VI

Process accounting data and assess payment of duties and/or taxes based on chosen revenue model

Rate	Goods	Price
Duty/Tax Rate	Seller Article (Item) Number(HS Code)	Currency
	Number of packages	Unit Price
	Total gross weight	Total Price
	Net Weight in Kg	Freight Charges
	Country of Origin	Other fees (insurance, etc.)
	Quantity	
	Invoice (with reference number)	

Figure C.7: E-commerce data elements.



Name	Goods	Identifier	Other
Seller's or supplier's name and address/ID	Seller Article (Item) Number(HS Code)	Declaration Identifier e.g. Full or simplified	Collector of cargos (if collector is different from express carrier);
Buyer's name and address/ID	Number of packages	Logistics Company Systems Authentication Identifier	Price on invoice
	Total gross weight	Buyer Identifier/Trader identifier	
	Net Weight in Kg	Identifier for shipping address that is different from consignee's address;	
	Country of Origin	Identifier for shipment treated by internet order business;	
	Quantity	Identifier for the existing of information on invoice;	
	Invoice (with reference number)	Fulfilment Company Systems Authentication Identifier	

Figure C.8: E-commerce data elements.

D

E-commerce multi-modal supply chain

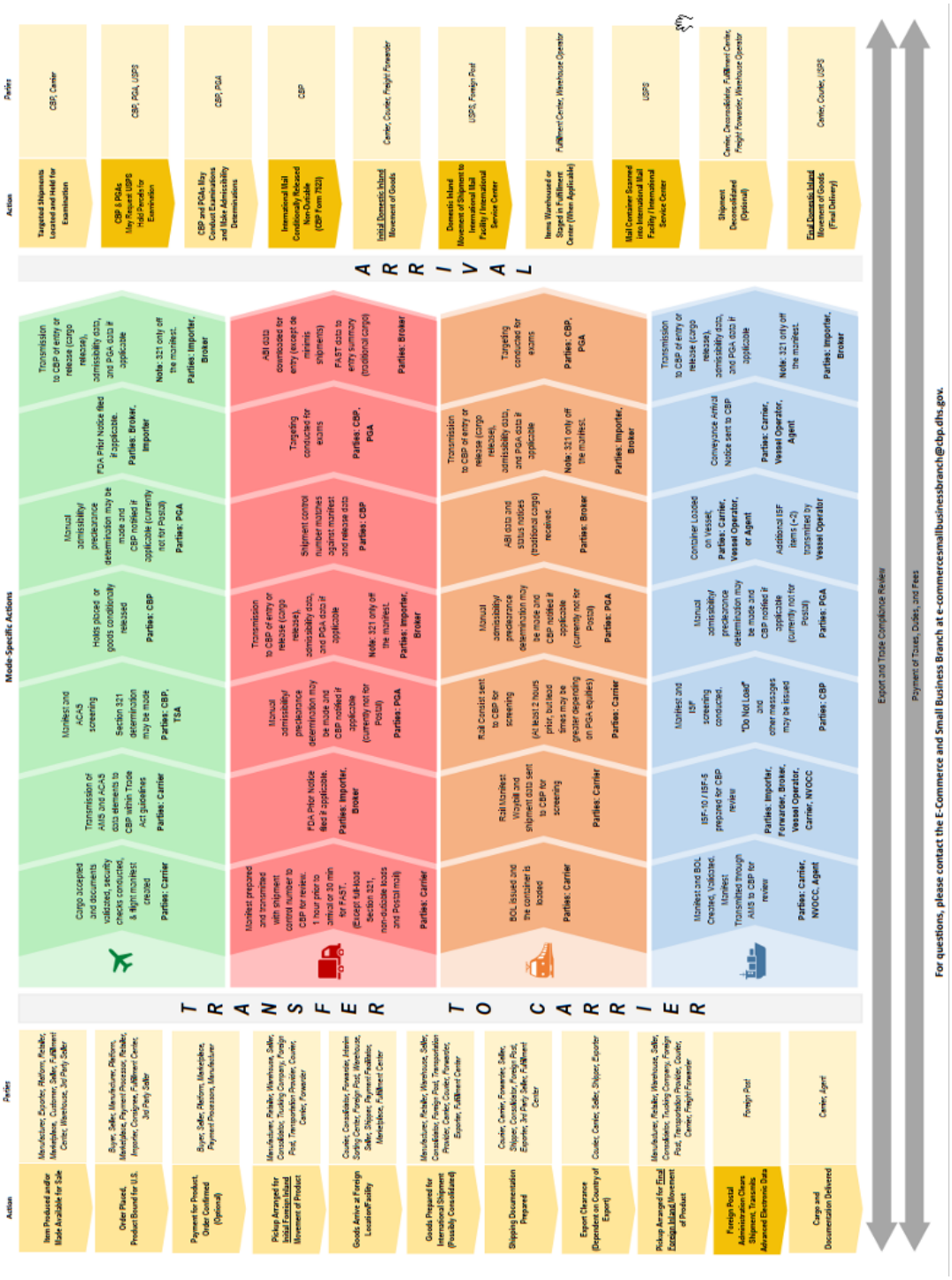


Figure D.1: E-commerce multi-modal supply chains. Source: COAC E-commerce Working Group [24].

E

CBP best practices for e-commerce platforms

The following table catalogs a set of high priority “best practices” that should be swiftly adopted by e-commerce platforms that operate third-party marketplaces, and other third-party intermediaries.

1. Comprehensive "Terms of Service" Agreements
2. Significantly Enhanced Vetting of Third-Party Sellers
3. Limitations on High Risk Products
4. Efficient Notice and Takedown Procedures
5. Enhanced Post-Discovery Actions
6. Indemnity Requirements for Foreign Sellers
7. Clear Transactions Through Banks that Comply with U.S. Enforcement Requests
8. Pre-Sale Identification of Third-Party Sellers
9. Establish Marketplace Seller IDs
10. Clearly Identifiable Country of Origin Disclosures

Source: CBP [12].

F

Partner government agencies that require documentation to clear or license cargo for import

Department	Agency	Examples of agency function
Department of Agriculture	Agricultural Marketing Service	Inspects certain imported fresh and processed fruits, vegetables, and speciality crops to verify that they meet the same requirements as domestic products subject to certain quality and condition requirements
Department of Agriculture	Animal and Plant Health Inspection Service	Regulates the import of animals, plants or their products; can prohibit entry of products that do not meet health or phytosanitary standards, do not have import permits from the service, or do not have certain foreign government certifications
Department of Agriculture	Food Safety and Inspection Service	Regulates the import and export of meat, poultry, and eggs.
Department of Agriculture	Food Agricultural Service	Administers tariff rate quotas and issues import licenses for sugar and dairy products.
Department of Commerce	Bureau of Industry and Security	Administers the Export Administration Regulations, which set forth license requirements for the export of items that have chiefly commercial users, but could potentially be used for human rights abuses/terrorism.

Department of Commerce	National Marine Fisheries Service	Regulates the importation and exportation of certain fish such as swordfish, tooth fish, and tuna; uses information on imports to identify illegal importations or exportations of fish, and to assist in its investigations of illegal fishing or related violations.
Department of Defense	Defense Contract Management Agency	Responsible for ensuring Department of Defense federal acquisition programs(systems, supplies, and services) are delivered on time, within project cost or price, and that they meet performance requirements; acts as customs broker for the department for goods being shipped into the United States to department activities.
Department of Health and Human Services	Centers for Disease Control and Prevention	Regulates imports that can potentially cause disease in humans and requires permits for disease-causing agents, biological materials, and certain animals/animal products.
Department of Health and Human Services	Food and Drug Administration	Regulates the importation of food, drugs, cosmetics, medical devices, biological, tobacco, and radiation-emitting products.
Department of the Interior	Fish and Wildlife Service	Determines the admissibility and controls the export of most wildlife and wildlife.
Department of Justice	Bureau of Alcohol, Tobacco, Firearms and Explosives	Regulates importation of arms, ammunition, implements of war, destructive devices, and explosives requires licenses and permits for the importation of some of these items.
Department of Justice	Drug Enforcement Administration	Regulates the import of controlled substances and listed chemicals that may be used to manufacture controlled substances; issues permits for certain controlled substances and monitors their movement.
Department of State	Bureau of Ocean and International Scientific Affairs(Office of Marine Conservation)	Provides a list to CBP and Congress of nations importing shrimp harvested in a manner that does not pose a threat to sea turtles.
Department of State	Directorate of Defense Trade Controls	Controls the export and temporary import of defense articles and defense services covered by the U.S. Munitions List.

Department of Transportation	National Highway Traffic Safety Administration	Monitors imported motor vehicles and motor vehicle equipment to ensure compliance with applicable Federal motor vehicle safety standards.
Department of the Treasury	Alcohol and Tobacco Tax and Trade Bureau	Issues permits to alcohol and tobacco importers; approves labels for alcoholic beverages imported into the United States.
Independent agency	Consumer Product Safety Commission	Monitors consumer products, including those being imported into the United States, to protect children and families against unreasonable risk of injury and death from thousands of types of consumer products; uses import information to determine which shipments to stop and examine, as well as to identify shipments where entry can be facilitated.
Department of Commerce	Enforcement and Compliance	Administers laws involving antidumping and contervailing duties; sets duty rates and provides CBP with cash deposit and liquidation instructions on entries subject of these duties.
Independent Agency	Environmental Protection Agency	Performs port of entry inspections, conducts follow-up inspections of import materials at importers of record or ultimate consignees, and carries out other investigative activities for enforcement actions authorized by certain environmental statues; regulates importation of ozone depleting substances, vehicles and engines, fuels and fuel additives subject to the Clean Air Act, pesticides and devices subject to the Federal Insecticide, Fungicide and Rodenticide Act, and chemical substances and chemical mixtures subject to the Toxic Substances Control Act.
Department of Commerce	Office of Textiles and Apparel	Administers tariff rate quotas on certain worsted wool fabrics; monitors all textile trade agreements and provides economic analysis, data, and information on Textiles
Independent Agency	Office of the United States Trade Representative	Responsible for developing and coordinating U.S. International trade, Commodity, direct investment policy, and overseeing negotiations with other countries.

F. Partner government agencies that require documentation to clear or license cargo for import

Source: GAO [22].

G

Agencies and entities involved in addressing e-commerce challenges

This appendix provides a brief summary of select agencies and entities to address e-commerce challenges. It is not a comprehensive list of all government agencies and partner organizations that have e-commerce related activities.

COAC E-Commerce and Other Related Working Groups

The Commercial Customs Operations Advisory Committee (COAC) provides recommendations to the Secretaries of the Treasury and DHS on improvements to the commercial operations of CBP. CBP's Office of Trade leads the COAC E-Commerce Working Group, which focuses on policy challenges surrounding the increase of e-commerce shipment volumes. COAC members are representatives of the individuals and firms affected by the commercial operations of CBP. The COAC members are appointed by the Secretary of the Treasury and the Secretary of DHS. In addition to the E-commerce working groups, other COAC working groups with e-commerce concerns are, the Intellectual Property Right (IPR) Working Group with a focus on IPR protection and policies against counterfeit e-commerce transactions, the Emerging Technologies Working Group focusing on assessment of various emerging technologies and their applications to CBP and trade issues, and the Unified Entry Working Group which focuses on development of an operational framework of unified entry process.

HSI E-Commerce Working Group

E-Commerce Working Group of Homeland Security Investigation (HSI) aims to facilitate data sharing, exchange of intelligence and best practices, and forge cross-sector collaborations to fight against e-commerce challenges including counterfeiting and piracy. It includes members of online marketplaces, payment platforms, and express consignment operators. Timely sharing of information among the stakeholders is one the main goals of the working group.

USPS

USPS is the designed postal operator in the U.S. One critical mission of USPS is to receive electronic EAD for inbound international mail. USPS provides received EAD to CBP for purposes of risk assessment and targeting before mail items arrive at the international service centers. USPS also works with the State Department to reach data exchange agreements regarding EAD with foreign postal operators and UPU.

Universal Postal Union (UPU)

The Universal Postal Union (UPU) – an agency of United Nations, is in charge of developing standards and policies of postal delivery for all the member countries around the world. UPU has been developing standards, guidelines and capabilities aimed at making data available electronically in the postal operator environment. This includes efforts to create electronic Customs Declaration System (CDS) on the basis of joint messaging standards, which will enable customers to enter data about an item on-line and enable postal services to provide advance data about postal shipments. In particular, UPU worked with WCO on developing WCO/UPU Customs-Post EDI Messaging Standards to implement the advance electronic exchange of information between the Customs authorities and postal services in practice.

WCO

WCO's Cross-Border E-Commerce Framework of Standards provides common standards, technical specifications, and guidelines for the effective management of cross-border e-commerce from both facilitation and control perspectives. This constitutes a set of customs standards (15 in total) on: Advance Electronic Data and Risk management; Facilitation and Simplification; Fair and Efficient Revenue Collection; and Safety and Security, etc. These Standards provides operational solutions that WCO Members have started engaging other relevant government agencies and e-commerce stakeholders - facilitate exchange of information between Customs and e-commerce intermediaries (including marketplaces).

WCO developed Immediate Release Guidelines applicable to low value consignments (below the de minimis threshold). The guidelines facilitate the pre-arrival processing and risk management of the consignments based on advance electronic information; streamline and expedite the handling of the consignments upon arrival; assist Customs administrations in determining data requirements and the exact procedure to be applied.

21CCF

CBP's 21st Century Customs Framework (21CCF) aims to provide a structured modernization approach that will enable the U.S. Government to address modern trade challenges, leverage emerging opportunities, and achieve transformational long-term changes. These include developing modernized process and applying emerging technologies that can enhance data integrity, account for emerging stakeholders in cross-border commerce and business practices, and achieve better facilitation of trade by reducing financial and ad-

ministrative burdens and constraints in customs transactions.

TSN

The Trade Support Network (TSN) provides a forum for the trade community to provide recommendations and input on customs automation and modernization. There are approximately 450 members of the TSN that represent the entire breadth of the trade community. The TSN includes software developers that comprise the TSN Technical Advisory Group. Their responsibilities include technical and operational input on the design and development of the Automated Commercial Environment (ACE). TSN members support the trade community in adapting new CBP processes and system updates, participating in testing of new functionality.

H

CBP Section 321 data pilot

To address the challenges of e-commerce, CBP has initiated several pilot programs.

Section 321 data pilot - 84 Fed Reg. 35405 (July 23, 2019)

Section 321 data pilot is designed to improve CBP's ability to identify and target high risk shipments, specifically for Section 321 entries in small packages, by collecting additional data from the participating carriers, e-commerce platforms, brokers, and other e-commerce actors. As part of this voluntary program, participants of the pilot electronically transmit to CBP certain additional data elements that are not required under the existing regulations for packages under the U.S. de minimis value of $800.

The purpose of the pilot program is to alleviate the challenge that CBP faces in efficiently targeting packages below the de minimis threshold given that CBP does not receive adequate advance information to assess the importation risk of these packages. Data elements transmitted to CBP through this program include: the name and address of the seller, the shipper, an enhanced product description, a hyperlink to the product listing, a picture of the product, the listed marketplace prices, etc.

According to report, as of July 2020, CBP has received enhanced data for more than 20 million shipments through this pilot. CBP plans to continue these efforts and will leverage the information gained to further develop policies and administrative measures for the Section 321 environment.

Source: CBP [8].

I

Data flow for air cargo

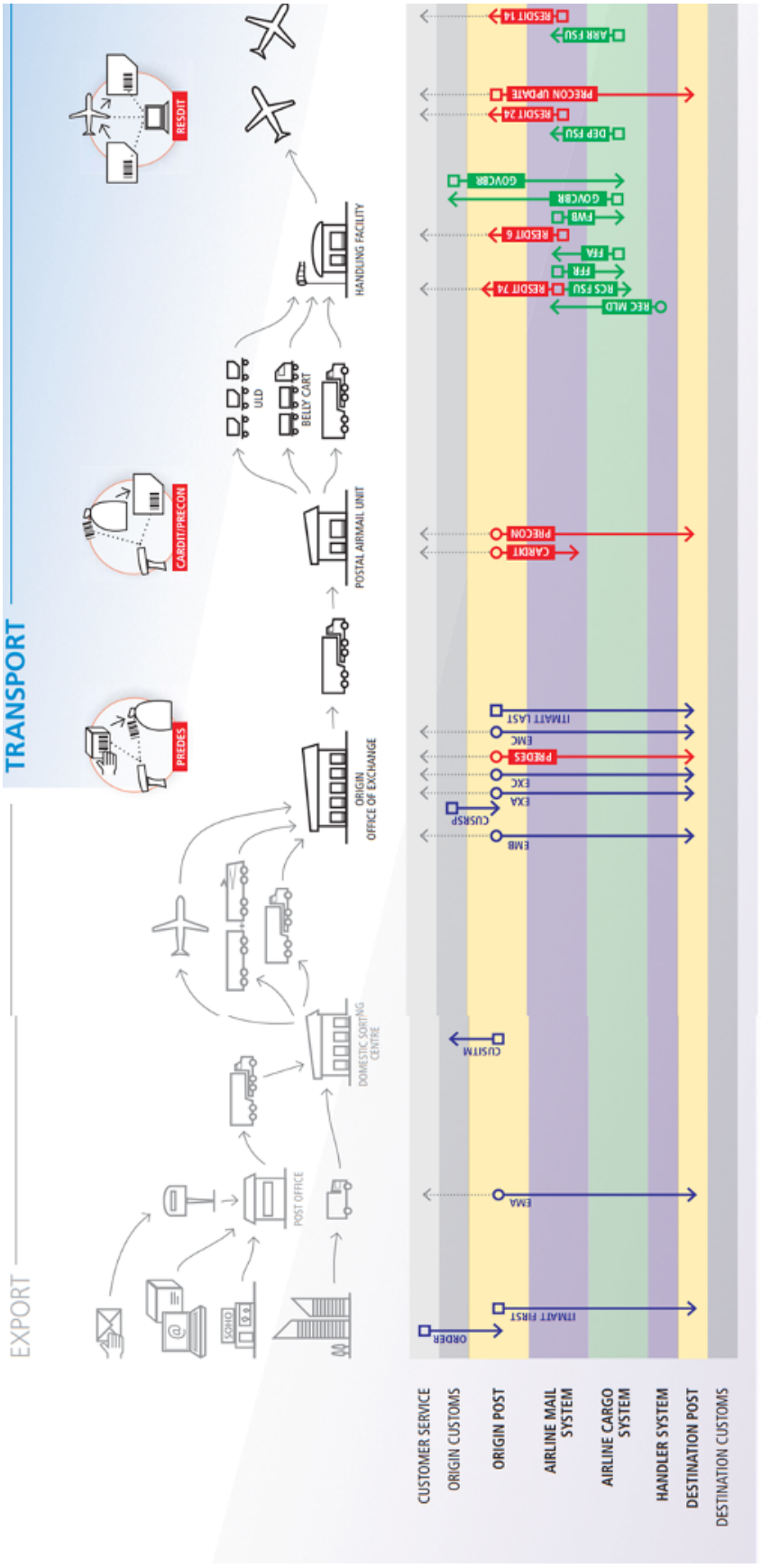


Figure I.1: Air cargo data flow.

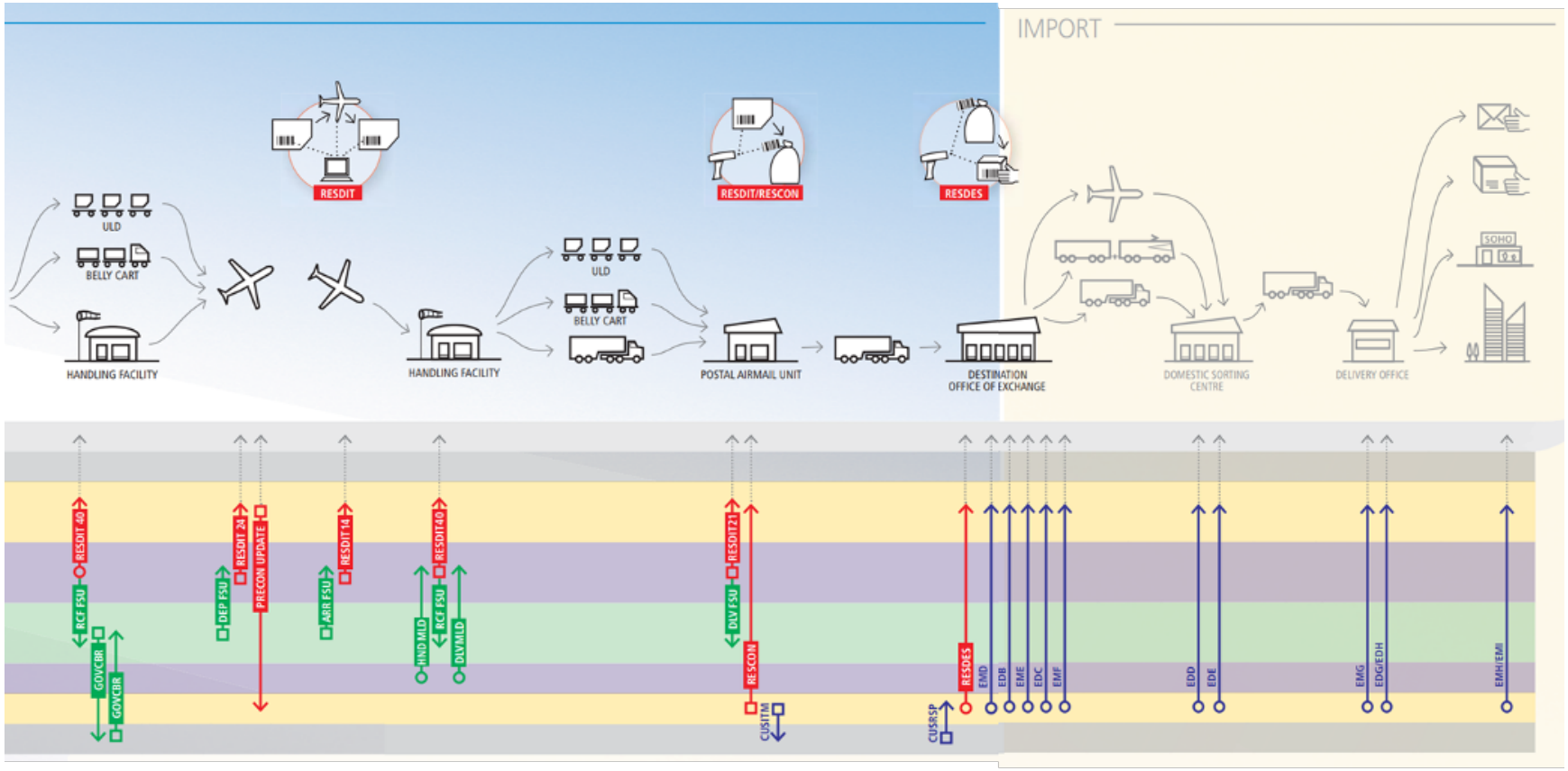


Figure I.2: Air cargo data flow.

EDI Providing end-to-end airmail visibility. Source: Joint publication of the Universal Postal Union, the International Air Transport Association, and the International Post Corporation [26, 27].

J

Postal/Customs processes at an inward office of exchange

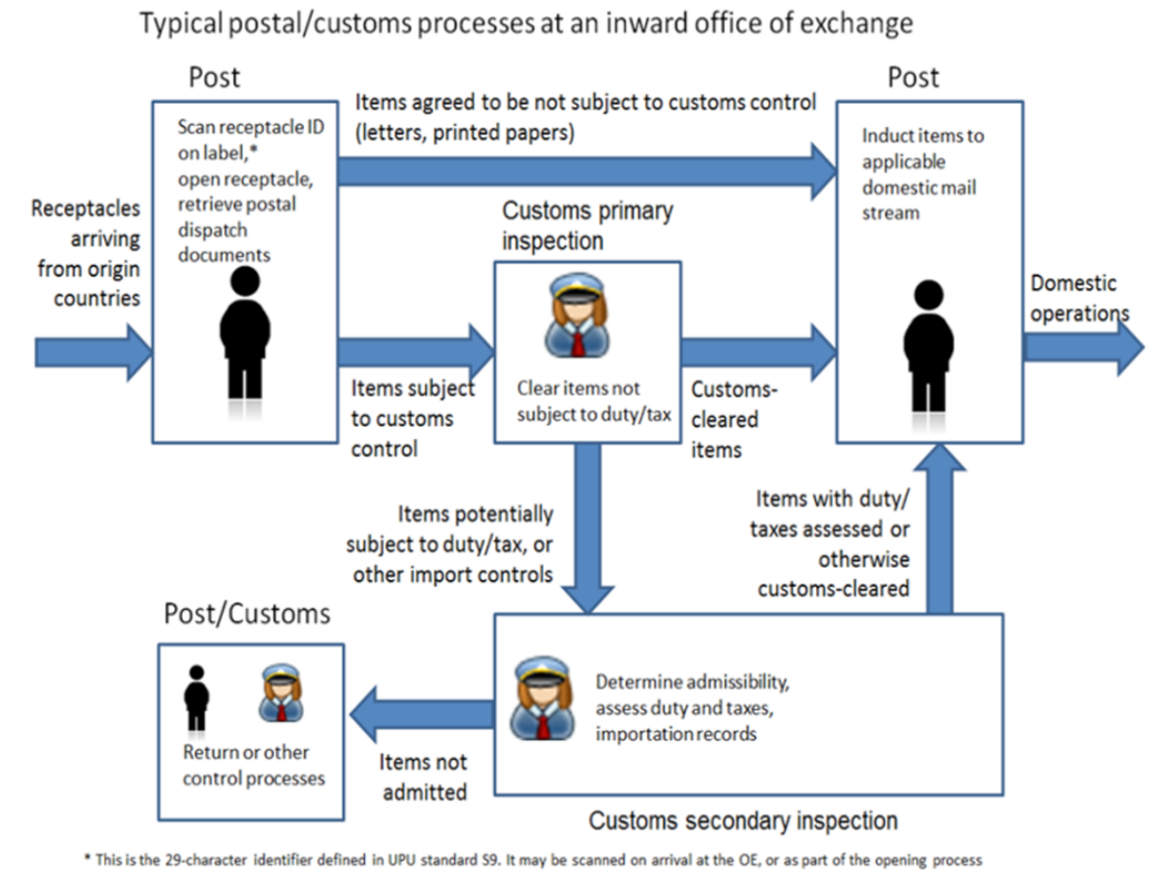


Figure J.1: Postal - Customs processes at an inward office of exchange.

Source: UPU.

K

EAD flowchart for postal network

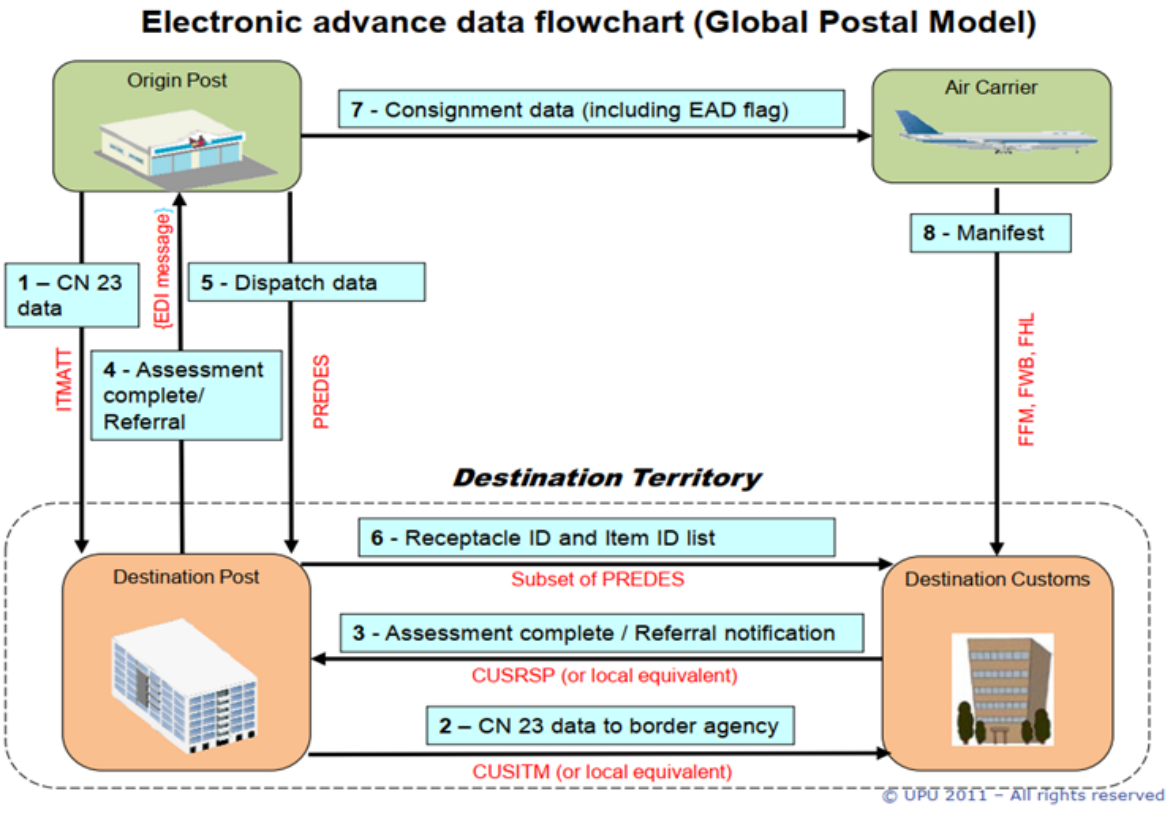


Figure K.1: EAD flow for postal network.

Source: WCO–UPU Postal Customs Guide.

L

Linked data examples

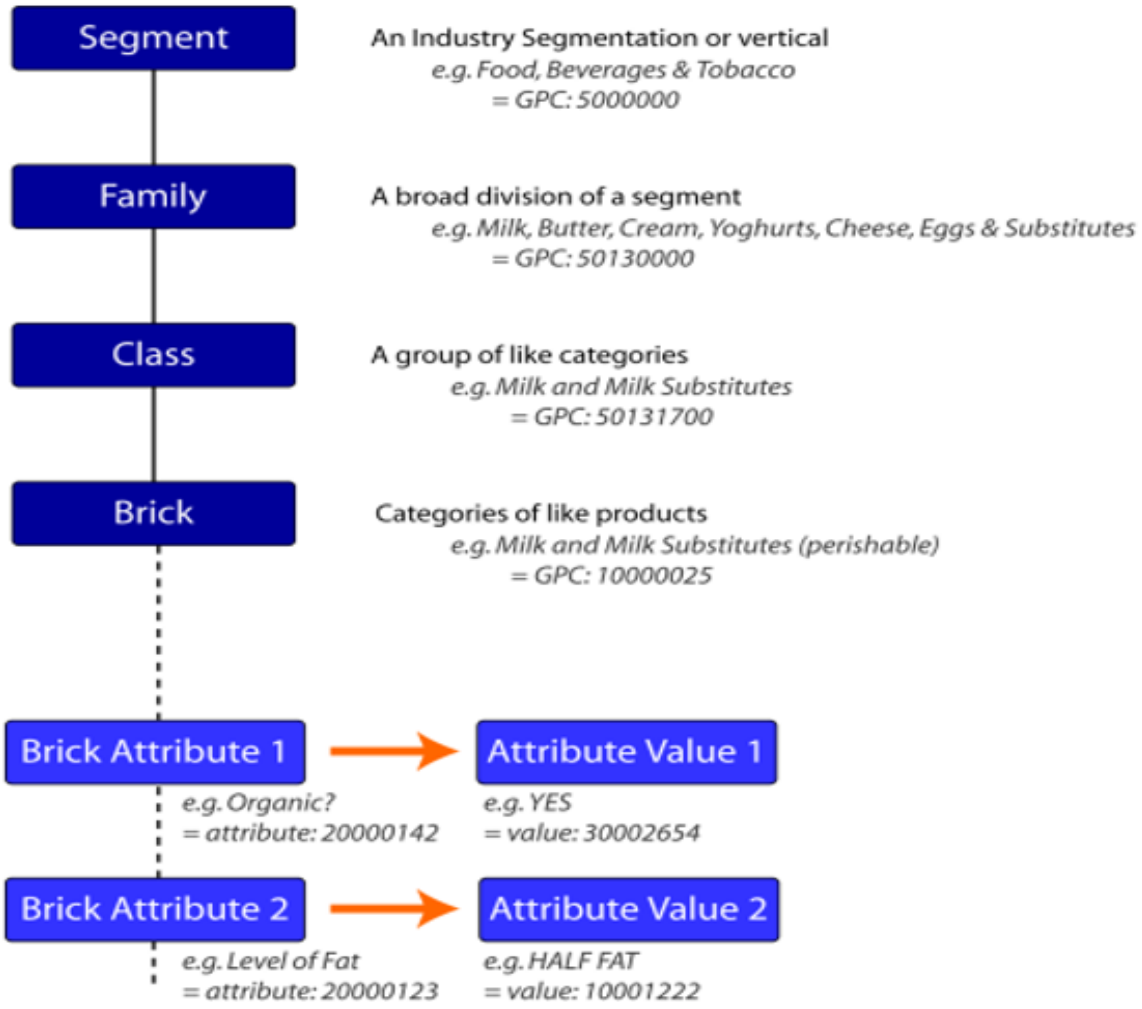


Figure L.1: GS1 Global Product Classification hierarchy - an example.

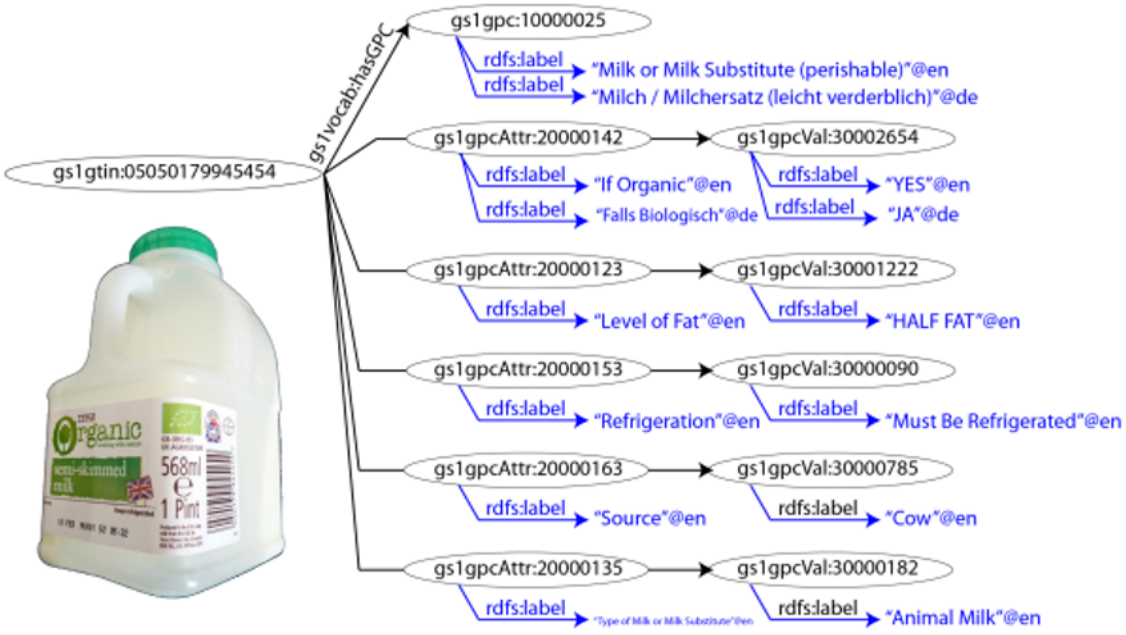


Figure L.2: Illustration of product information as linked data (GTIN, GPC bricks and GPC attributes.)

Source: Auto-ID Labs [25].

M

Technical summary of the digital distributed ledger risk model

M.1. Effects on the U.S. government

M.1.1. Data sharing channel

As digital distributed ledger is incorporated into U.S. government importing procedures, there are two things that happen to the probability of data sharing. The first is that the probability that CBP will not have sufficient data to verify that a shipment is legal and safe for speedy entry will go down. This is because the ability of various stakeholders to submit false or insufficient data for entry is more difficult, as the distributed ledger cannot move forward without some levels of verification. Stakeholders will be more likely to fill out data in this case.

Second, the probability that there will be some importation delays if the correct data is not shared will go up. This is because with automated distributed ledger technologies, CBP or the relevant PGA's will be automatically notified if a party has not submitted their data or their data has not been verified by the relevant stakeholders.

The data sharing channel of effects on the U.S. government can be therefore described as:

The probability of illicit shipments coming through U.S. Customs=P(stakeholders that have not provided sufficient data, Relevant importing parties have not caught the illicit shipment)

M.1.2. Importation delays channel

As the probability that stakeholders will share data goes up, average importation delays should go down, as CBP or relevant PGAs will have more data to verify shipments. On the other hand, as the probability that the relevant agencies will catch illicit shipments goes up, average importation delays should also go up. Thus, the average importation delays channel for the U.S. government is also a function of the joint probability that stakeholders have not provided sufficient data and that the relevant agencies have not caught the illicit shipment.

M.1.3. Net customs margin

We call the average customs charges collected on a shipment "the net customs margin" and it is calculated as the customs charges per day per unit of the shipment, say, if the shipment is illicit and held and customs. This net margin drives a wedge between the price the importer pays and the price the foreign seller receives and has the effect of a deadweight loss. In theory, the costs of the deadweight loss or the associated inefficiencies could be borne by the foreign seller, the US importer, US consumers and businesses, and other stakeholders. In practice, the distribution of the costs depends on marketplace characteristics and the degree of competition.

(A note on terminology: The U.S. government as a matter of course will incur costs and benefits with respect to a shipment transitioning to a distributed ledger. We call the average customs charges collected on a shipment "the net customs margin" but this should not be construed as a profit margin.)

M.2. Effects on U.S. consumers

M.2.1. Importation delays channel

U.S. consumers will benefit from less delays using the distributed ledger technology. Thus, the importation delays channel that applies to the U.S. government will also apply to U.S. consumers, as well as U.S. business importers.

M.2.2. Cost of shipping channel

Digital distributed ledger will change the cost to doing business for some stakeholders. As the cost of importing changes, there is a possibility for pass-through of those import costs to the consumer. This model does not directly address the pass-through effects; thus, the costs of shipping channel is described below in the effects on businesses.

M.3. Effects on businesses

M.3.1. Cooperation versus non-cooperation

This model distinguishes between shipments where stakeholders cooperate and send sufficient data for speedy entry versus those who do not and may be subject to importation delays. Non-cooperation will change the landed cost per unit of the shipment for the various stakeholders, as when somebody does not cooperate, there is then a probability of a certain range of importation delays.

The landed cost per unit is a standard calculation, where:

$$C = \textit{Per Unit Cost} + \textit{Data Sharing Technology Costs} + \textit{Freight and Shipping} + \textit{Customs Duties} + \textit{Labor} + \textit{Customs Charges from Delays}$$

Cooperators will have no charges from delays in either the status quo or digital distributed ledger scenarios. However, digital distributed ledger will lower the costs to cooperation, so there will be less non-cooperation overall. Importation delays will also decrease with digital distributed ledger.

M.3.2. Importation delays channel

Like the U.S. government and U.S. consumers, importers and businesses will also benefit if there are lower importation delays from digital distributed ledger.

M.3.3. Labor channel

Stakeholders will likely benefit if digital distributed ledger can lower the hours worked that it takes to share data. In the status quo, labor is calculated as an hours-worked calculation multiplied by an hourly payment to wages and salaries. If the shipment has importation delays, there will be more hours worked for data sharing. Digital distributed ledger will change the labor hours worked, by both overall amount and by risk tier.

M.3.4. Technology channel

Transitioning to digital distributed ledger will also mean many companies also transitioning away from the technologies required of the status quo ACE/legacy environment. The ACE/legacy environment costs are, static across risk levels associated with the shipment, and include monthly costs to broker/stakeholder interfaces, as well as compatible systems for the ACE software. The digital distributed ledger costs are estimated across five

years including onboarding (initial technology investments), cloud-based software, monitoring, and ongoing maintenance. Both costs are estimated on a per transaction basis. If ACE/legacy is more expensive than digital distributed ledger on a per transaction basis, there will be savings from technology. If ACE/legacy is less expensive than digital distributed ledger, then there will be net expenses on the technology side.

M.4. Capturing uncertainty

In order to understand the uncertainty of the data sharing environment on both the shipping and enforcement side, this model utilizes a Monte Carlo method for simulations, and relies on repeated random sampling to obtain the expected values of a shipment between the status quo and digital distributed ledger, as well as a distribution of results. In this way, we captured the randomness of a question that is overall deterministic in nature.

N

GS1 global data synchronization network

The Global Data Synchronization Network (GDSN) is an internet-based, interconnected network of interoperable data pools governed by GS1 standards. The GDSN enables companies to exchange standardized product master data with their trading partners. The GDSN is used to support registration and look up of product data through use of authoritative data sources with standardized data formats.

The GDSN operates using a publish-subscribe pattern between two trading partners, each of which are registered with and access the GDSN via a data pool. The GS1 Global Registry acts as a directory to point to the data pool where data is stored. GDSN stored data includes the GLN and the GTIN.

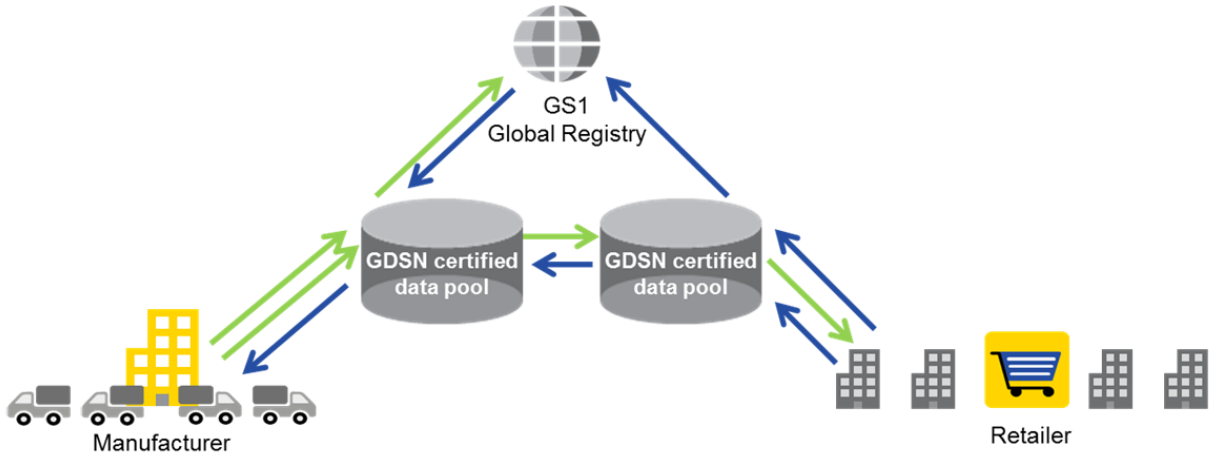


Figure N.1: GS1 GSDN.

Glossary

ACE Automated Commercial Environment. 34, 42, 60, 113

AEO Authorized Economic Operator. 15, 20–23, 25, 31–33, 35, 44, 88, 89

AI Artificial Intelligence. 8, 31, 36, 42, 46, 47, 49, 84, 90

API Application Programming Interface. 10, 13, 38, 56

ASTM American Society for Testing and Materials. 42

B2B Business to Business. 3, 18, 40, 42, 43

B2B2C Business to Business to Consumer. 12

B2C Business to Consumer. 3, 12, 18, 20, 43, 47, 52

B2G Business to Government. 40, 43

C2C Consumer to Consumer. 12, 18, 47

CBP U.S. Customs and Border Protection. 3, 4, 6–8, 10–12, 22, 23, 34, 58–60, 62, 82, 83, 86, 88, 91, 111–114, 131

CBRA Customs and Cross Border Regulatory Agencies. 12, 34, 35

CDS Customs Declaration System. 112

CEN European Committee for Standardization. 40

CNN Concurrent Neural Network. 48

COAC Commercial Customs Operations Advisory Committee. 10, 13, 111

COO Country of Origin. 15, 22, 25, 26, 52

CRS Congressional Research Service. 8

CUSITM UPU item-level message from destination DO to its customs organization (Provides Customs with information to enable customs control, such as determination of duty or tax). 83

CUSRSP UPU item-level message from Customs to destination DO (Provides destination DO with feedback from Customs concerning the item, including customs clearance of the item. 83

DHS U.S. Department of Homeland Security. 7

DID W3C Decentralized Identities. 37

DLT Distributed Ledger Technology. 37, 46, 49–53, 57, 58, 90, 132

EAD Electronic Advance Data. 83, 84, 91, 112

EAN European Article Numbering. 7

EANCOM EAN + Communication - standard messages were developed by GS1. 41, 42

eCO Electronic Certificate of Origin. 43

EDI Electronic Data Interchange. 38, 40–42, 44, 83, 112

EDIFACT Electronic Data Interchange For Administration, Commerce and Transport. 44

EIF European Interoperability Framework. 40, 44, 45, 131

EPA Environment Protection Agency. 11

EPC Electronic Product Code. 42, 43

EPCIS Electronic Product Code Information Service. 42

FCA False Claim Act. 20

FDA Food and Drug Administration. 4, 11, 25, 50, 52, 53, 132

G2G Government to Government. 40, 44

GAO U.S. Government Accountability Office. 83

GDSN Global Data Synchronization Network. 126

GLN Global Location Number. 43, 126

GPC GS1 Global Product Classification. 42, 57

GS1 Global Standards One. 41, 43, 45, 58, 126

GTIN Global Trade Item Number. 4, 7, 43, 126

HSI Homeland Security Investigation. 111

HTS Harmonized Tariff Schedule. 8, 46, 47, 131

IATA International Air Transport Association. 36

ICAO International Civil Aviation Organization. 36

ICT Information and Communication Technologies. 31, 35, 37, 51, 89

IoTs Internet of Things. 8, 50

IPR Intellectual Property Right. 4, 15, 19, 22, 26, 36, 39, 51, 52, 86, 87, 111

ISO International Organization for Standardization. 42, 43

JSON Java Script Object Notation. 44

LPCO Licenses, Permits, Certificates, and Others. 15, 26, 52

LSP Logistics Service Provider. 11, 12

ML Machine Learning. 8, 19, 46–49, 90, 134

MSME Micro, Small and Medium Enterprises. 3, 11, 21, 22, 31, 32, 34, 51, 52, 58, 89, 90

NIEM National Information Exchange Model. 45

OECD Organisation for Economic Co-operation and Development. 59

OWL Ontology Web Language. 44, 45, 53, 58

PGA Partner Government Agencies. 4, 12, 15, 21–23, 26, 34, 35, 40, 46–49, 52, 59, 87, 131, 132

PSP Payment Service Provider. 11

RDF Resource Description Framework. 38, 40, 44, 53, 55–57

SGTIN Serialized Global Trade Item Number. 43

SSCC Serial Shipping Container Code. 43, 83

TFTEA Trade Facilitation and Trade Enforcement Act of 2015. 5, 17

TSN Trade Support Network. 113

UN/CEFACT United Nations Center for Trade Facilitation and Electronic Business. 42, 43, 45, 58

UNSPSC United Nations Standard Products and Services Code. 42, 43

UPC Universal Product Code. 4, 7

UPU Universal Postal Union. 36, 42, 82–84, 112

URI Universal Resource Identifier. 53, 55, 56, 58

USCPSC U.S. Consumer Product Safety Commission. 5

USITC United States International Trade Commission. 3, 42

USPS United States Postal Service. 4, 12, 81–83, 112

VAT Value Added Tax. 20

W3C World Wide Web Consortium. 44

WCO World Customs Organization. 4, 10, 13, 14, 21, 36, 42, 45, 51, 55, 58, 83, 88, 112, 131

WSJ Wall Street Journal. 4

XML eXtensible Markup Language. 38, 40–42, 44, 45

XSD W3C XML Schema Definition Language. 38, 44

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