Analysis of the Impact on Waterborne Containerized Imports at the Ports of Seattle and Tacoma from a Potential Public Utility Tax Applied by the State of Washington

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January 25, 2023

Executive Summary

This report provides an analysis of the impact on import container volumes through the Ports of Seattle and Tacoma from a potential public utility tax (PUT) applied by the State of Washington. This tax would be applied to freight transportation shipments in the State in the amount of 1.926% of the freight charges. For interstate shipments, a portion of the freight charge, in proportion to the mileage within Washington divided by the overall mileage, would be assessed the tax.

To assess the impact, the author applied his Elasticity Model. This analytical model optimizes the Far East – USA waterborne, containerized supply chains importer by importer so as to minimize total transportation, handling and inventory costs. Estimated 2019 import volumes for the top 90 actual importers are included in the model, plus that for 16 generic importers representing small and regional importers calibrated and stratified so as to much the actual distribution of declared values by volume according to 2019 US Customs data.

The model predicts very minor diversion of containerized imports away from the Northwest Seaport Alliance ports (Seattle and Tacoma) to other ports outside Washington as a result of imposition of the PUT, on the order of 2,000 – 2,500 TEUs (twenty-foot equivalent units) per year out of a 1.39 million TEU annual import volume at the NWSA ports.

Consultant Background and Methodology

I will begin this report with a summary of my professional background and academic training, highlight my experience in analyses to predict international container volumes by port, and then present the specific analysis of the potential tax.

I received the AB degree in Mathematics and Physics in 1973, the MS degree in Operations Research in 1975, and the PhD degree in Industrial Engineering and Operations Research in 1979, all from the University of California at Berkeley. During semester breaks and summers in 1970, 1971, 1972 and 1975, I worked various positions in the Operating Department of the Oregon Division of the Union Pacific Railroad. During the years 1973 and 1974 I worked as a Service Planning Analyst in the Marketing Department of Union Pacific Railroad. During the period 1977 – 1982 I worked as a Planning Engineer, Senior Engineer and an Associate Engineer

for Alan M. Voorhees & Associates, later PRC Planning & Economics, a nationally-recognized transportation planning firm. Beginning in 1979 I joined the faculty of the Dept. of Industrial Engineering and Operations Research at the University of California at Berkeley, rising to the rank of Full Professor in 1992, a position I now hold. In 1983 I founded Leachman & Associates, and I continue to serve as Principal for this limited liability company (LLC). Leachman & Associates provides consulting and software for the management and design of supply chains and for economic and capacity analysis of freight transportation.

Since 2003 I have directed the development and application in policy analysis of a large-scale economic model embracing all waterborne containerized imports from Far Eastern countries to the Continental United States. The model computes optimal supply chain strategies for each of the 90 largest importers of Far Eastern goods to the USA, plus optimal supply chain strategies for each of 16 generic importers serving as proxies for all other small and regional importers. The import volumes for these generic importers are calibrated such that there is a match between the total commodity volumes and the distribution of declared values in U S Customs data on such imports and those in the model. For this purpose, Port Import-Export Reporting Services – Trade Intelligencer (PIERS-TI) and Global Trade Atlas (GTA)[1] summaries of US Customs transactions on waterborne, containerized imports from the Far East to the United States for calendar 2005, 2015 and 2019 were secured by the author. The supply chains are optimized by the model in the sense of providing the lowest total logistics costs including all costs for transportation and handling plus holding costs for pipeline inventories and destination safety-stock inventories of the imported goods. The model is calibrated with PIERS-TI and GTA data concerning declared values for Far Eastern imports stratified into 99 commodity types and import volumes for the 106 importers; US Census data on purchasing power by State and County; rate quotations and confidential contract rates from ocean carriers, intermodal marketing companies, and third party logistics providers for large and small importers; and statistics concerning container flow times by port and landside transportation channels. Destinations included in the model are 22 popular sites for regional distribution centers across the Continental USA. The import volume to each site is assumed to be proportional to the fraction of total Continental USA purchasing power within the region served by the site. Supply-chain volumes from all importers calculated by the model are aggregated to predict import volumes by port and landside transportation channel for each of 13 potential North American ports of entry, including the Ports of Seattle and Tacoma, and the 22 destination regions (e.g., the region local to the Puget Sound ports includes Washington, Oregon, Idaho and Montana). This model is known as the Elasticity Model because repeated calculations of the model may be used to assess the impact of potential changes in transportation rates or port fees in terms of shifts in import volumes by port or channel. I wish to emphasize that the model works entirely from the point of view of importers. Changes in transportation or port costs to ocean carriers are assumed to be passed through from ocean carriers to their importing customers.

The Elasticity Model has been applied in policy analysis for the San Pedro Bay, Oakland and Puget Sound ports to assess the impact of potential or existing container fees and of potential infrastructure improvements at those ports and in landside transportation channels serving those ports. It also has been applied to assess and re-engineer the supply chains of some of the largest American importers of Far Eastern goods. The Southern California Association of Governments

[1] PIERS-TI and GTA are commercial data service products of IHS Markit.

has made publicly available the consulting reports describing the Elasticity Model and results of its application in policy analysis for the San Pedro Bay ports.[2] The methodology underlying the Model also has been published in the academic journal *Transportation Research*.[3] In recognition of this research, I served as an Associate Editor of the journal.

My Elasticity Model has been used in studies of containerized imports at the Puget Sound ports. During the second half of 2007 I applied the Elasticity Model to analyze the port and modal elasticity of imports routed through the Puget Sound ports with respect to potential container fees. In January, 2008 I submitted a report to the Washington State Department of Transportation in support of their Freight Mobility Study entitled "Port and Modal Elasticity of Containerized Asian Imports via the Seattle-Tacoma Ports." In the same month I testified at a legislative committee hearing on the matter. In October, 2011 I applied the Elasticity Model to assess the impact of proposed changes in fees charged by the Puget Sound Pilots. In December, 2011, I applied the Elasticity Model to assess the impact of the Harbor Maintenance Fee on the allocation of Far East – USA containerized imports to North American ports of entry, sponsored by the Port of Tacoma. In 2016, I applied the model to assess Far East – USA containerized supply chains under the sponsorship of the Intermodal Transportation Institute at the University of Denver. In 2020, I applied the model to assess the impact of proposed changes to the tariff of the Puget Sound Pilots applied to waterborne containerized imports via the Ports of Seattle and Tacoma (hereafter collectively referred to as the Northwest Seaport Alliance, or NWSA for short). In that study, an increase in the Pilots' tariff of $1.36 per TEU (twenty-foot equivalent unit), or $2.72 per FEU (forty-foot equivalent unit), was found to have little or no effect on import or export container volumes through the NWSA ports.

My analysis and conclusions concerning the impacts on waterborne, containerized imports from the potential PUT are explained as follows.

A Brief Primer on Supply Chain Strategies and Terminology

Any supply chain for retail goods has factory origins and retailing destinations. In a *Push* supply chain, shipping of goods is closely tied to factory production schedules. In typical Push supply chains, production and shipping are performed at a contracted steady rate throughout the year, thereby minimizing investment and operating costs for manufacturing and transportation.

In a *Pull* supply chain, shipping of goods is more closely tied to retail sales. Typically, retail sales fluctuate over the course of the year (e.g., large sales volumes towards the end of the year associated with Christmas gift-giving, large sales volumes during promotions), and so shipping quantities in Pull supply chains fluctuate more than in Push supply chains.

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[2] See Leachman, Robert C. *Final Report, Port and Modal Elasticity Study*, prepared for the Southern California Association of Governments, Sept. 2005. Report may be downloaded from the SCAG web site, http://www.scag.ca.gov/goodsmove/pdf/FinalElasticityReport0905rev1105.pdf, and Leachman, Robert C., *Final Report, Port and Modal Elasticity Study – Phase II*, prepared for the Southern California Association of Governments, Sept. 2010. Report may be downloaded from the SCAG web site, http://www.scag.ca.gov/goodsmove/elasticitystudyphase2.htm

[3] See Leachman, Robert C., 2008. "Port and Modal Allocation of Waterborne Containerized Imports from Asia to the United States," *Transportation Research Part E*, **44** (2), p. 313 – 331 (March, 2008).

Pull supply chains focus on controlling inventory costs and enabling increased sales, at the expense of higher costs for manufacturing and transportation. In contrast, Push supply chains focus on minimizing production and transportation costs, at the risk of higher inventory-related costs.

To decide shipping rates in Push supply chains requires long-range forecasts of sales. If such forecasts are prone to error, there can result panic adjustments to the Push shipping plan, e.g., cancellation of long-term shipping contracts (in the case of a forecast turning out much too high) or emergency shipments paying high spot prices for shipping (in the case of a forecast turning out much too low).

A compromise strategy is a *Push-Pull* supply chain, in which an inventory stocking point situated in between production source and sales outlets is deployed. The location of the inventory point is termed the *Push-Pull boundary*. Goods are pushed from factory to stocking point, then pulled from stocking point to sales outlets.

When there are geographically-dispersed sales outlets in the supply chain, a common supply chain strategy is to ship from factory to an inventory stocking point or a de-consolidation point without pre-allocation to sales outlets, then prepare an allocation plan and re-ship from the stocking point or de-consolidation point to sales outlets. If the shipping time from this point to the sales outlets is much shorter than the shipping time from factory to this point, the forecasts of sales at outlets made just in time for shipping from this point to sales outlets will be much more accurate than forecasts made just in time for shipping direct from the factory. Moreover, shipping from factory to this point need only rely on a forecast of total sales across all outlets, which percentage-wise, will be much more accurate than forecasts of sales at individual outlets.

If the de-consolidation point is simply a cross-dock or trans-load facility with no capability to stock inventory, then any excess in overall supply from the factory must be pushed onto the sales outlets. Any excess can be proportionately spread across the retail outlets, thereby minimizing the inventory consequences. Similarly, a shortage in overall supply from the factory can be proportionately spread across retail outlets. If the de-consolidation point includes a warehouse able to stock inventory, then excess supply from the factory can be held for deployment to mitigate future shortages rather that proportionately pushed on the retail outlets, and the resident inventory can be tapped to make up for a shortage in supply arriving from the factory. In that case, lower inventory-related costs and higher sales can be achieved, in exchange for the expense of maintaining the warehouse and its inventories.

Typically, a well-designed Push-Pull supply chain can garner much of the shipping economies of a Push supply chain, as well as much of the inventory economies of a Pull supply chain. Thus, it embodies a strategy superior to either extreme. Of course, there are many alternative specific configurations of a Push-Pull supply chain, e.g., where should the Push-Pull boundary be located, which shipping modes should be used, should there be just a trans-load facility or also a warehouse?. The most effective specific configuration will depend on the relative magnitudes of shipping-related and inventory-related costs.

Table 1 provides a glossary of supply-chain acronyms and terminology.

Table 1: Glossary of Supply Chain Acronyms and Terminology

Term or Acronym	Meaning
Cross-dock or trans-load facility	A facility for unloading cargoes from inbound vehicles, sorting them, and re-loading the cargoes in outbound vehicles. The typical cross-dock is not designed to hold inventory for extended periods of time, so the arrival of inbound and outbound vehicles must be coordinated.
Cube freight	A cargo which entirely fills the cubic capacity of a trailer or container before reaching the weight limit for highway movement.
DCS	Dedicated Contract Service. For regular, periodic re-stocking of its regional retail outlets from a regional distribution center, a large retailer may charter drivers, truck tractors and sometimes trailers for long periods of time to carry out such transportation.
Drayman, Dray carrier	Containers or trailers moving in rail intermodal service may require over-the-road movement between origin and initial rail terminal and between final rail terminal and destination. A company operating a fleet of truck tractors making such short, same-day trips is a dray carrier. Some such companies are essentially dispatch coordinators for a group of owner-operators, each of whom is known as a drayman.
Domestic container	A shipping unit for truckload-sized intermodal shipments within North America, using the railroad for line haul. Domestic containers are fifty-three feet in length and accommodate 4,000 cubic feet of cargoes. For movement from origin to initial rail terminal and for movement from final rail terminal to destination, the container is mounted on a chassis and pulled by a dray tractor on roads and highways.
Domestic trailer	A shipping unit for truckload-sized shipments within North America. Domestic trailers are fifty-three feet in length and accommodate 4,000 cubic feet of cargoes. A trailer may be towed by a truck tractor for over-the-road movement, or it may be drayed to and from rail intermodal terminals for line-haul movement in trains. Wheels and undercarriage are permanently attached so trailers cannot be double-stacked.
Domestic rail service	The shipping of a domestic 53-foot container or trailer using a train for much of the line haul. IMCs, LTL companies, package express and parcel shipping companies utilizing domestic rail service.
IMC	Intermodal Marketing Company. A company marketing door-to-door transportation within North America of domestic 53-foot containers and utilizing domestic rail service. An empty container and a chassis are retrieved from a rail intermodal terminal in proximity to the origin warehouse or cross-dock, and

	delivered to the origin for loading. After loading the container-on-chassis, it is drayed back to the rail terminal where the container is transferred using an overhead crane to a railroad well car. The container is moved in a double-stacked train 600 miles or more to a destination rail terminal, then drayed from the rail terminal to the destination warehouse. The IMC subcontracts with dray companies to provide the origin and destination drays and with a railroad to provide the line haul.
Import Warehouse	Large nation-wide retailers typically operate an import warehouse in the hinterland of one or more ports of entry. Goods imported months in advance of time of sale may be held in the import warehouse, and later allocated and shipped to RDCs closer to the time the goods can be sold.
ICTF	Intermodal Container Transfer Facility. The ICTF is a Union Pacific Railroad intermodal terminal located close to the San Pedro Bay Ports, handling both domestic rail and IPI shipments.
IE	Inland Empire region of Southern California, located 60-90 miles from the SPB Ports. The Inland Empire hosts the largest concentration of import warehouses, NDCs and RDCs in Southern California.
IPI	Inland Point Intermodal. A transportation service marketed by ocean carriers in which marine containers move via vessel, railroad double-stack train, and highway dray movement. In the case of a marine container shipped from a Far East origin to an inland North American destination, the container is transferred from a vessel to a railroad well car at a West Coast port of entry, moved 600 miles or more in a double-stacked train to an inland rail intermodal terminal, then drayed from the rail terminal to the destination warehouse. The ocean carrier subcontracts with dray companies to provide the destination dray and with a railroad to provide the line haul. IPI service also is available for exports.
LTL	Less-than-truckload. LTL carriers provide door-to-door shipping of pallet-sized shipments, using small trucks to pick up and deliver, consolidating multiple shipments into domestic containers or domestic trailers for line-haul movement, and de-consolidating the multiple shipments for final delivery.
Marine container	The shipping unit for waterborne, containerized international shipping. Marine containers come in twenty, forty and forty-five foot lengths. Over 80% are forty feet in length, and nearly all of those in the trans-Pacific trade accommodate 2,700 cubic feet of cargoes.
NDC	National Distribution Center. An OEM may operate a single distribution center serving all its North American retailing customers, who must arrange transportation from the OEM's NDC to their own RDCs.

NWSA	Northwest Seaport Alliance, referring to the Ports of Seattle and Tacoma.
Ocean Carrier	In the context of this report, a company providing trans-Pacific shipping of marine containers.
On-Dock Rail	A marine terminal equipped to transfer marine containers to railroad well cars without need to dray outside the terminal is said to have on-dock rail capability. On-dock rail is exclusively for IPI shipments.
OEM	Original Equipment Manufacturer. Waterborne, containerized imports of certain relatively valuable goods are made by the OEM companies who market such goods rather than by the OEM"s retailing customers. In such cases, the OEM carriers handle the international transportation. Once goods are purchased from the OEM by a retailer, further transportation is typically the responsibility of the retailer.
Package Express and Parcel carrier	Package Express and Parcel carriers provide door-to-door shipping of carton-sized shipments, using small trucks to pick up and deliver, consolidating multiple shipments into domestic containers or domestic trailers for line-haul movement, and de-consolidating the multiple shipments for final delivery using smaller vehicles.
Push supply chain	In the context of this report, an import strategy in which there are steady shipment volumes from Far East factories to RDCs so as to minimize total shipping costs. IPI service is used for RDCs located more than 600 miles from ports of entry, while dray movement of marine boxes is used for RDCs located closer to ports of entry. Typically, many ports of entry are utilized, assigning each RDC to the closest port of entry in order to economize on landside shipping costs.
Push-Pull-all-at-San-Pedro-Bay supply chain	An import strategy in which all imports from Far East factories for the Continental USA market are routed through the SPB Ports, then re-shipped in domestic containers and trailers to RDCs. Imports may be held for some time at an NDC (OEM case) or an import warehouse (case of large, nation-wide retailer) before re-shipment to an RDC.
Push-Pull-3[4][5]-Corners supply chain	An import strategy in which goods manufactured in the Far East are allocated to 3, 4 or 5 pre-specified North American ports of entry before booking vessel passage, but not allocated to specific RDCs. After arrival at port of entry, goods are allocated to RDCs served by the port of entry, and re-shipped to distant RDCs in domestic containers or trailers. Imports may be held for some time at an import warehouse in the hinterland of the port of entry before re-shipment to an RDC.
RDC	Regional Distribution Center. A typical brick-and-mortar retailer utilizes an RDC to warehouse goods sold by retail outlets within a geography served by the RDC. Typically, an RDC

	serves a set of retail outlets reachable within an overnight drive from the RDC (but sometimes longer distances in some sparsely populated regions).
SPB Ports	The San Pedro Bay Ports, i.e., the Port of Long Beach and the Port of Los Angeles in Southern California
TEU	Twenty-foot equivalent unit, a metric of waterborne containerized shipping. One forty-foot marine container equals two TEUs.
Weight freight	A commodity which, when loaded in a container or trailer, causes the vehicle to reach the highway weight limit before the cubic capacity of the vehicle is reached.
West Colton	An industrial community in the Inland Empire of Southern California and site of a Union Pacific Railroad domestic rail terminal.
3PL	Third-party logistics operator. Cross-docks and trans-load facilities may be operated by 3PLs in lieu of the beneficial owner of the cargoes handled (first party) or the transportation carrier (second party).

Overview of Contemporary Far East – USA Import Supply Chains

Containerization and intermodal transportation dramatically lowered the costs of international shipping, enabling American companies to tap low-cost Asian manufacturing. The resulting improvement in international supply chain efficiency and reliability facilitated the outsourcing of American manufacturing which began in the early 1980s and accelerated through the 1990s. From 1980 to 2006, the total waterborne, containerized imports from Asia to North America via West Coast ports grew rapidly. Figure 1 displays the total containerized imports through major US and Canadian West Coast ports during the period 1999 – 2015.[4] Volume doubled from about six million twenty-foot equivalent units (TEUs) in 1999 to almost 12 million TEUs in 2006, before a deep recession arrested import growth. While imported container volumes declined for several years following 2006, by 2015, imports via West Coast ports surpassed the 2006 peak. In 2015, there were about 15 million TEUs of containerized imports from the Far East, of which 51% passed through the San Pedro Bay ports, 33% passed through East Coast or Gulf Coast ports, and 16% passed through the other West Coast ports.

Ocean carriers providing containerized transport in the Far East – North America market offer three basic service products. Under CY (container yard) service, the ocean carrier supplies an empty container to the Far East origin factory or warehouse, drays the loaded container to the origin port, and provides vessel transport to a North American port. It is the responsibility of the importer to bring tractor and chassis to the North American port to pick up the box. SD (store door) service is the same as CY except the ocean carrier also pays for a dray from the North American port to a destination warehouse in the hinterland of the port. Originally, under SD service the ocean

[4] Includes only inbound loaded international containers. Ports included: Long Beach, Los Angeles, San Francisco, Oakland, Portland, Tacoma, Seattle, greater Vancouver metro area, and Prince Rupert. *Source*: Port websites.

Figure 1: Total Containerized Imports through US and Canadian West Coast Ports 1994-2015 (TEUs)

Sources: Port web sites.

carrier hired a local drayman and provided a chassis for the destination dray. However, the ocean carriers no longer provide chasses, and most importers prefer to control the dray themselves using draymen they employ or contract. When an importer purchases SD service but performs the dray itself, the ocean carrier rebates the destination dray cost. The third service product is IPI (inland point intermodal). Under IPI service, shipments move intact in marine containers from Far East origins to inland USA destinations using a combination of modes: initial dray by truck from Far East origin to Far East port, vessel from Far East port to North American port, double-stack train from North American port to inland rail terminal, and then final dray by truck from rail terminal to destination. In the case of IPI service, the ocean carrier sells a door-to-door transportation product, subcontracting a drayman in the Far East to dray an empty box from the Far East port to the factory origin and dray the loaded box to the origin port, subcontracting a North American railroad to haul the box from the destination port to a distant inland rail intermodal terminal, and subcontracting a North American drayman to haul the box from the destination rail terminal to the receiver's dock.

If the importer wishes to de-van the imports from the marine container, sort them at a cross-dock or inventory them at a warehouse, and subsequently re-ship them, he can procure CY or SD service from the ocean carrier to move the imports to the cross-dock or warehouse in the hinterland of the port of entry, but then he must hire a domestic landside transportation company for re-shipment

from cross-dock or warehouse to the desired inland destinations. He can hire a trucking firm for movement of goods in a 53-foot trailer. He can hire an LTL (less than truckload) carrier for movement of pallet-sized shipments. He can hire UPS or Fed Ex Ground for even smaller shipments.

Securing rail intermodal service for full truckloads is a different story. Except Wal-Mart and Amazon, importers cannot procure rail intermodal service directly from the railroads. They must procure this service from a third party known as an Intermodal Marketing Company (IMC). Examples of IMCs include J B Hunt, Hub Group, and Schneider. The IMC sells the door-to-door service of shipping a 53-foot domestic container or trailer from importer's cross-dock or warehouse to destination warehouse, sub-contracting with a railroad for line haul. Some IMCs have their own drivers, dray tractors, containers, and chassis; others sub-contract with dray companies to perform origin and destination drays, and they secure chasses and containers from the railroad.

Figure 2 summarizes these terms of trade. For intact movement in marine containers, the importer need only do business with the ocean carrier. For a supply chain in which goods will be de-vanned from marine containers before continued movement from the hinterland of the port of entry, the importer is hiring a port area dray company to bring the box from the port to the cross-dock or warehouse and hiring a chassis provider for that move. It may hire a third-party logistics company (3PL) to operate the cross-dock. For outbound movements from the cross-dock, it hires an IMC for the re-shipment in domestic containers from cross-dock or warehouse to distant inland destinations and trucking companies for re-shipment in trailers to points for which rail intermodal service is unavailable or not competitive.

The investments made by West Coast ports, the railroads and marine terminal operators, facilitated rapid growth in the movement of IPI shipments for over two decades. However, changes in the nature of retailing in the US, along with increases in the size of domestic containers and the commercial incentives to use the large domestic containers provided by railroads, shifted the growth vector in international containerized transportation from intact to trans-loaded shipments.

The cubic capacity of domestic intermodal containers paced the increase in size of highway trailers, growing from 45 feet to 48 feet to 53 feet in length. Combined with aggressive pricing spurred by modal competition, low-cost domestic container service drove a major shift away from intact international container shipments. By the mid-2000s, virtually the entire domestic container fleet in the Continental USA consisted of 53-foot containers. Their cubic capacity is about 4,000 cubic feet, compared to about 2,700 cubic feet for a "high-cube" 40-foot marine container that is nine feet, six inches tall, and compared to about 2,400 cubic feet for an ISO 40-foot marine container that is eight feet, six inches tall. For "cube" freight, i.e., freight that reaches space limits before reaching highway weight limits, the contents of three marine containers fit in two domestic containers or trailers.

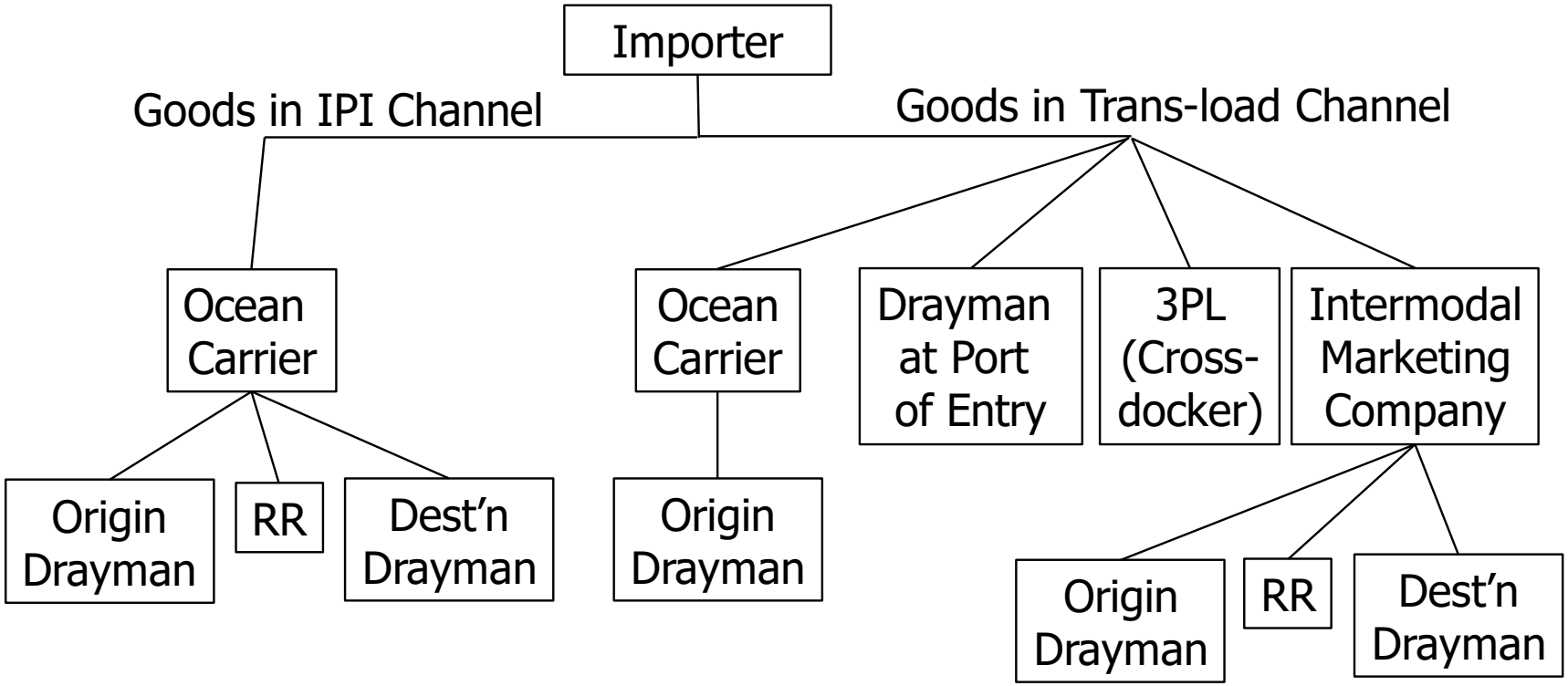

Figure 2. Contractors and Sub-contractors in Far East – USA Waterborne, Containerized Supply Chains

Demand for larger domestic containers was driven by an evolution in the mix of importers and an associated increase in the sophistication of supply chain management. The 1980s and 1990s saw the rise of nation-wide "big-box" retailers such as K Mart, Wal-Mart, Target and Home Depot. The big-box firms steadily took more and more market share from small and regional retailers. These large, nation-wide retailers enjoy economies of scale and scope that enable a new and more efficient kind of supply chain to be embraced, a supply chain in which goods do not move intact in marine containers from Far Eastern factories to stores or regional distribution centers (RDCs), but instead are de-vanned and sorted in the hinterlands of the ports of entry, then allocated to RDCs and re-shipped in domestic trailers or containers. This re-allocation happens subsequent to the long lead time to book vessel passage and move goods from an interior point in the Far East to a USA port of entry, with only the much shorter lead times remaining to move the goods from port of entry to the RDCs across the USA. Much more accurate projections of sales in various regions are available over these shorter horizons than for the long horizon facing the importer before vessel passage was booked. Re-allocation of goods by RDC destination after arriving at port of entry enables a much better match-up of supply and demand to be made.[5]

The average time until sale of goods is thereby reduced, and, consequently, the average pipeline inventory is reduced, and the required safety stocks at RDCs are sharply reduced. Thus, this sort of supply chain is especially attractive for goods with high inventory costs or rapid price erosion.[6] Better yet, if the imported goods at the time of arrival at port of entry are not yet in demand at any RDC, they can be stored in an import warehouse in the hinterland of the port of entry and shipped later once demand materializes, in lieu of immediate, speculative shipment to what could turn out to be the wrong RDC (wrong in the sense that, if the items had been shipped to a different RDC, they could have been sold much earlier, perhaps at higher prices.)

Considering the cubic capacity advantage of domestic trailers and containers over international containers, the transportation cost savings associated with the reduced number of inland container shipments afforded by domestic containers partially offsets the extra handling and drayage costs associated with de-vanning marine containers, sorting and re-allocating the goods, and reloading them in domestic containers. This savings extends the portfolio of goods for which supply chains that re-allocate goods after arrival at port of entry and re-ship them in domestic containers and trailers are superior to supply chains involving intact shipment in marine containers to inland distribution centers. The economies large nationwide retailers derive from such supply chains are not available to a retailer operating retail outlets in only one region (because there are not multiple RDCs in multiple regions with offsetting sales fluctuations whose

[5] Wal-Mart was the first champion of widespread application of *cross-docking* in its supply chains, whereby a fleet of inbound containers or trailers from multiple origins is brought to a dock where their contents are unloaded, sorted and re-allocated to a fleet of outbound containers or trailers heading to multiple destinations. This technique enables better management of pipeline inventories by fine-tuning the alignment of supplies with demands. The technique is now intensely practiced by all of the nation-wide "big-box" retailers. A similar strategy is practiced by original equipment manufacturers (OEMs) bringing imported goods into the USA and re-selling them to US retailers, whereby the imports may be inventoried for some time pending sale and domestic re-shipment.

[6] Inventory costs are high when the declared value of the goods is high, when the retail price erodes very quickly (such as for fashion goods or electronics), and/or when sales are difficult to forecast (such as new toys).

inventories can be re-balanced by re-allocation of imports), nor are they available for small retailers (because the need to re-load from marine containers into domestic containers of a different size requires sufficient, sustained import volumes so that the result is not half-empty containers or trailers shipped domestically).

The recent rise of nation-wide e-commerce retailing, both by the Big-Box retailers such as Wal-Mart, Target and Home Depot, as well as by pure e-commerce enterprises, such as Amazon, has accelerated the shift of import volumes into such trans-loading supply chains. The economic gains in terms of quicker liquidation of inventory at higher average selling prices afforded by not making geographical commitments on pipeline inventory outweigh the extra handling costs associated with cross-docking and warehousing in the hinterlands of ports of entry. Moreover, direct shipping to customers using parcel and express services, without need to stock retail stores, enables on-line retailers to make much less geographical dispersion of imports, and maintain much less total inventory than otherwise.

Impact of the Pandemic

The 2020 COVID pandemic seriously disrupted supply chains for Far East – USA waterborne, containerized imports. First, consider what happened to retail sales (excluding the automotive sector), as depicted in Figure 3. The pandemic struck in March 2020. Retail sales in April collapsed. Many large retailers cancelled their annual contracts with ocean carriers for steady shipping of imports from the Far East, fearing a glut of imports they would not be able to sell. But unable to spend money on dining, entertainment and travel, American consumers focused on home remodeling projects and increased their acquisitions of electronics and other durable consumer goods. By July, retail sales had shot up to unprecedented levels and continued to sustain an extraordinary growth rate through March, 2021, leaving retailers scrambling to catch up. Not shown in the figure, there also was a substantial shift in retailing from sales in physical stores to on-line sales. Since March, 2021 retail sales have been fairly stationary, still at a high level. During the period July 2019 – July 2022, retail sales grew by 17.5%, a rate clearly unsustainable over the long run.

Next, consider what happened to import volumes, as depicted in Figure 4. Total import volume in 2020 started out similar to but slightly lower than that in 2019. With the reactions of retailers in April to the collapse in their sales, imports plummeted in May. By July, import volumes had fully recovered, and from August, 2020, through July, 2022, they were 15-40% above historical levels.

Meanwhile, supply chain capabilities cratered as workers took ill. The nature of marine terminals exacerbates any shortage of workforce vs. import volume. Import containers are piled on the terminal lot awaiting dray movement off the terminal. At most North American marine terminals, drays of the containers out of the terminal are controlled by the importers, not by the terminal operators. Terminal managers have little or no ability to stage containers in their order of departure, because the order of departure is unknown. When the pile is not too deep, there are not many containers in the way when a drayman shows up to retrieve a particular box. But as the pile gets deeper and deeper, more and more lifts are required to move boxes out of the way to

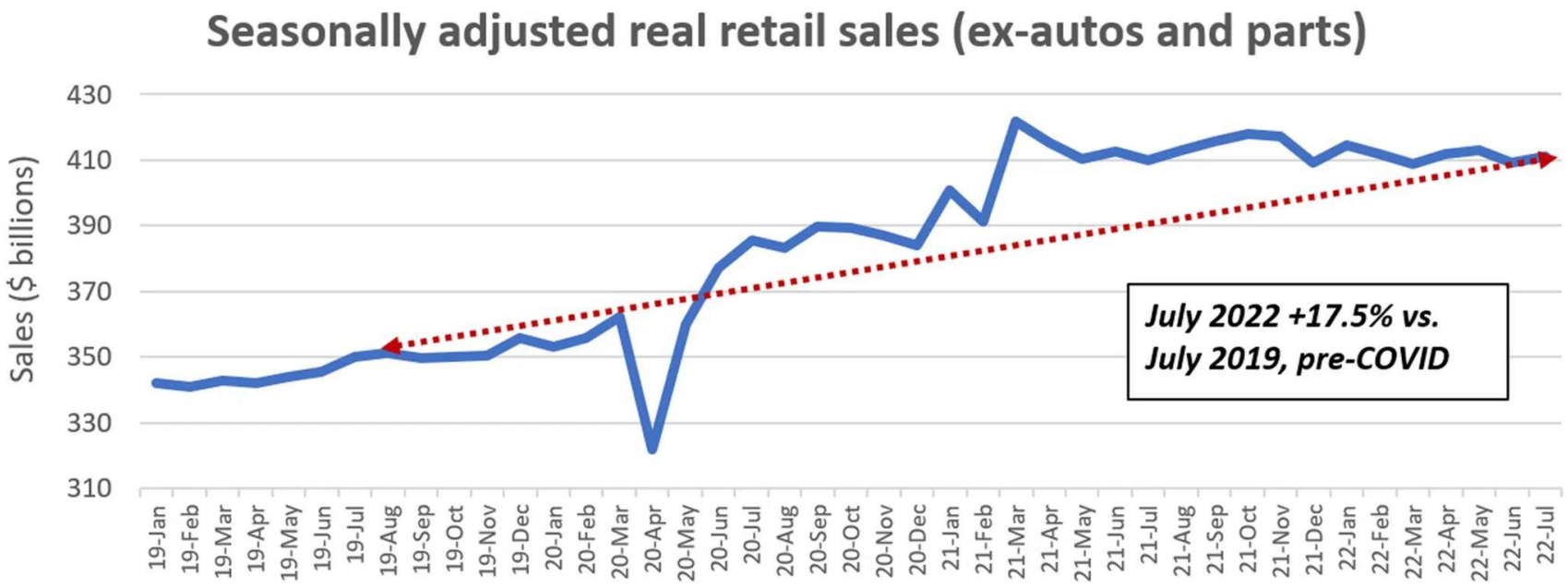

Figure 3. Monthly USA Retail Sales, 2019 - 2022

Sales figures shown are inflation-adjusted to 2019 dollars.
Source: *American Shipper*

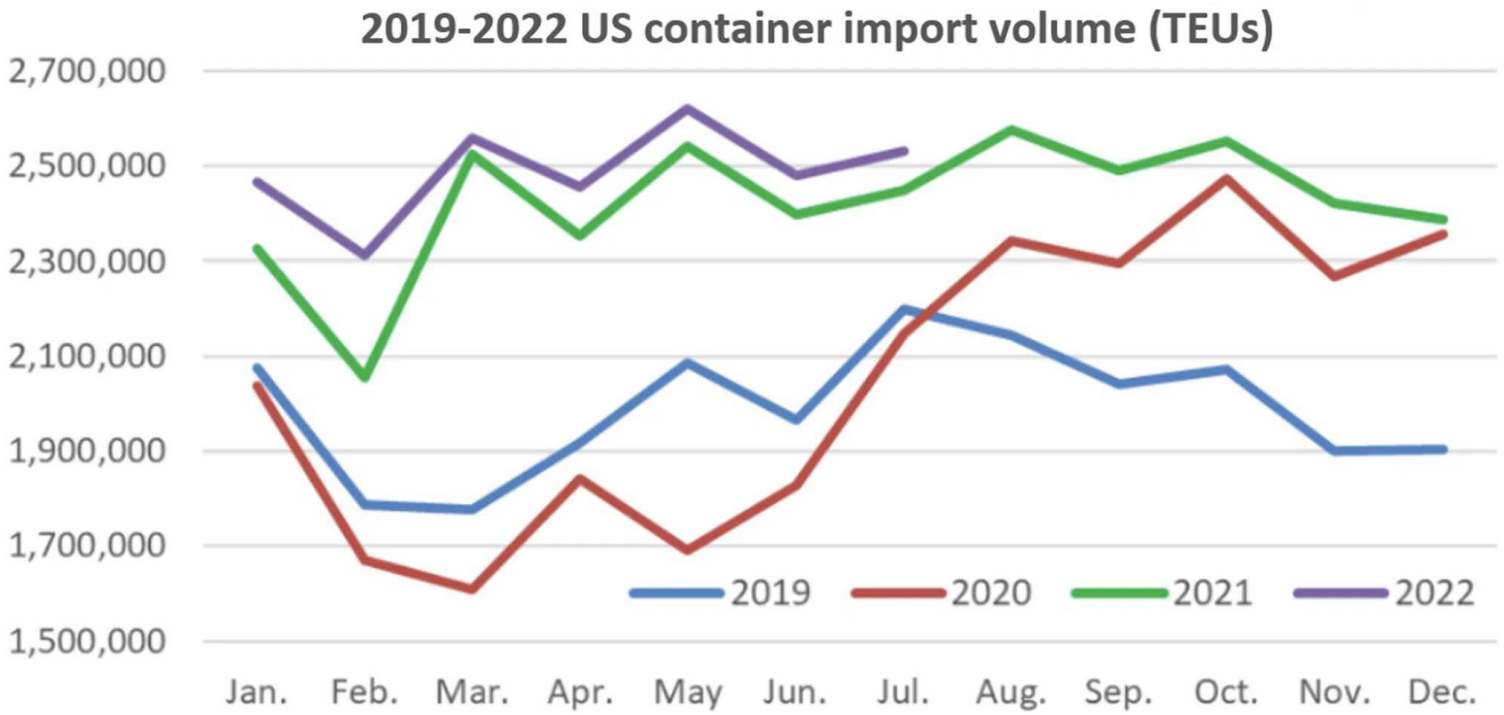

Figure 4. Monthly Waterborne Containerized Imports to the USA, 2019 - 2022

Source: Descartes Datamyne

retrieve the desired box. The workload is not proportional to volume; it is *super-linear in volume.* With a reduced staff and a surge in volume, marine terminals filled with containers. Empties coming back to the terminal were diverted to vacant lots, still on chasses. Chasses became scarce, containers became scarce. Ports filled up with container vessels at anchor. Some container vessels were diverted to other ports.

Further down the supply chain, with traffic dropping, the railroads furloughed many workers. Draymen making hauls from inland rail terminals to destination warehouses became scarce as they became ill or stayed home to avoid getting ill. Worse, warehouse workers became ill or were dismissed. With warehouses unable to unload containers, drays could not be dispatched, even if a driver could be found. So inland rail terminals filled up. Trains were parked out on the line.

The Federal government instituted a COVID relief package, providing unemployment benefits equivalent to about a $20 per hour job. For the non-union draymen, rail terminal workers and warehouse workers whose jobs paid on the order of $25 per hour, returning to work provided an increment of about $5 per hour but at the risk of contracting COVID. Many chose not to take the risk, prolonging the back-up. The railroads also have been unable (or perhaps unwilling) to recover their pre-COVID staffing levels.

Conceptually, rail movement of marine containers should have been less impacted by the pandemic than was dray movement, because IPI containers coming off vessels are staged by destination blocks adjacent to loading tracks at the marine terminal. Order within a block does not matter. The IPI containers can be promptly loaded into railroad well cars by a one-man top-picker (in contrast to the three-man rubber-tired gantry cranes used in the dray area of the terminal), as long as empty cars are spotted at the terminal. In sharp contrast to the dray area of the marine terminal, workload at the IPI area is linear in import volume. However, longshoremen assigned to man top-pickers also became scarce when the pandemic took hold. Worse, the railroads adjusted their train operations to reflect “precision scheduled railroading” (which is actually a policy of running longer and less frequent trains in order to reduce train labor costs), thereby straining marine terminals. More recently, the railroads have instituted much stricter attendance policies, and workers have responded by refusing to come back to work from furlough or by resigning. As recently as July, 2022, as many as 20 loaded marine container trains were holding at one time at the San Pedro Bay ports for lack of train crews.

By November, 2022, the queues of vessels awaiting unloading and piles of containers awaiting dispatch were much reduced from pandemic peaks, about the same as pre-pandemic levels at West Coast ports. From the Summer of 2020 until the Summer of 2022 retailers were desperate to get imports in any way they could, be it diverting imports to other ports, utilizing long-distance trucking, or whatever. Annual contract rates for movement across the Pacific at $2,500 or so per container were replaced by spot prices upwards of $12,000 per container, reportedly reaching as much as $20,000 during peak-demand periods. Labor rates and benefits for warehouse workers and draymen are on the rise. In late 2022 rail unions threatened a strike and will be getting higher wages and benefits (and perhaps improved working schedules). Serious inflation, so long dormant in the USA, returned.

At present, most large retailers have excessive inventories of many goods. Amazon has curtailed aggressive expansion plans for its network of fulfillment centers.

There are already indications that the share of consumer spending allocated to dining, entertainment and travel is returning to normal levels. Assuming the pandemic continues to fade and assuming staffing shortages are recovered, the ports, railroads and warehouses should soon catch up on their backlogs.

Because it has taken until the Fall of 2022 for shipping volumes and transportation prices for Far East – USA imports to return to more normal levels, data from the years 2020 through 2022 is deemed inappropriate to calibrate the model used in this study. The input data for this application of the Elasticity Model reflects 2019 overall Far East – Continental USA import volume, 2019 import mix by commodity, declared value and importer, 2018 transportation and handling rate quotations, 2018 purchasing power statistics, and 2015 container flow-time statistics. In this report, I refer to this data set as the Base Case data.

PUT Analysis

This analysis is conducted from the point of view of the importers making decisions on how to route their imports. For the purposes of this analysis, I assume that the PUT tax from the State of Washington assessed on transportation carriers would be fully passed on to the beneficial cargo owners (BCOs). In most cases the BCOs do not pay the transportation service provider directly, but instead pay an intermediary in turn subcontracting with transportation carriers to fulfill the transportation.

Before addressing the specifics of the Washington PUT situation, it is helpful to understand the the composition of containerized imports from the Far East to the Continental United States, the various supply-chain strategies for Far East – USA importers, and the competitive position of the NWSA ports.

Table 2 below shows NWSA international container volumes during 2019. Volumes are expressed in twenty-foot-equivalent units (TEUs). Marine containers come in three lengths: 20 feet (one TEU), 40 feet (two TEUs) and 45 feet (2.25 TEUs). The vast majority of international, waterborne containerized shipments are made in 40-foot containers. Use of 20-foot containers is largely restricted to dense commodities for which observance of highway weight limits means use of larger containers offers no economies to the BCO. 45-foot containers are often refrigerated containers with similar interior loading space to 40-foot containers; these are the least common types of marine containers. Table 3 displays a list of the top trading partners for the NWSA ports ranked by dollar value of trade in 2019. As may be seen, the list is dominated by countries in the Far East. Indeed, the Far East countries accounted for more than 90% of imports at USA West Coast ports in 2019.[7] Table 4 displays port shares of Far East – Continental USA waterborne, containerized imports for the calendar years 2005, 2015 and 2019. As may be seen, the share for the NWSA ports on a TEU basis dropped from 14.2% in 2005 to 7.9% in 2015 and to 7.3% in 2019.

[7] Source: PIERS-TI and GTA.

Table 2: Northwest Seaport Alliance 2019 International Container Volumes (TEUs)

Month	Import			Export			Import + Export		
	Loaded	Empty	Total	Loaded	Empty	Total	Loaded	Empty	Total
Jan 2019	128615	15978	144593	72859	60043	132902	201474	76021	277495
Feb 2019	99669	12207	111876	65610	44157	109767	165279	56364	221643
Mar 2019	117007	20084	137091	86856	52437	139293	203863	72521	276384
Apr 2019	112652	15221	127873	81305	56604	137909	193957	71825	265782
May 2019	111730	13121	124851	70541	51252	121793	182271	64373	246644
Jun 2019	122645	13320	135965	76559	59432	135991	199204	72752	271956
Jul 2019	122946	8965	131911	73828	52580	126408	196774	61545	258319
Aug 2019	112267	9929	122196	74852	58749	133601	187119	68678	255797
Sep 2019	131451	9619	141070	82148	56313	138461	213599	65932	279531
Oct 2019	109469	13072	122541	79321	49468	128789	188790	62540	251330
Nov 2019	94978	13570	108548	73589	33655	107244	168567	47225	215792
Dec 2019	105823	12688	118511	75868	43299	119167	181691	55987	237678
Total Year	1369251	157724	1594426	913332	617989	1576165	2282583	775713	3058296

Source: NWSA Web Site

Table 3
NWSA's Top Trading Partners in 2019

China	$23.7 billion
Japan	$15.0 billion
Vietnam	$3.9 billion
Republic of Korea	$3.6 billion
Taiwan	$2.7 billion
Thailand	$1.4 billion
Indonesia	$1.1 billion
Philippines	$0.7 billion
Malaysia	$0.7 billion
India	$0.6 billion
Australia	$0.5 billion
All other	$5.6 billion
Total	$59.4 billion

Source: NWSA Web site

Table 4
Port Shares of Far East - USA Waterborne, Containerized Imports (TEU basis)

Port of Entry	**2005**	**2015**	**2019**
Northeast	12.8%	16.7%	17.4%
Southeast	9.2%	13.8%	15.3%
Gulf Coast	1.2%	2.2%	5.1%
Subtotal, all-water	23.2%	32.7%	37.8%
San Pedro Bay	56.9%	50.7%	45.3%
Oakland	5.3%	4.3%	4.2%
Seattle-Tacoma	14.2%	7.9%	7.3%
British Columbia	0.5%	4.4%	5.3%

Sources: PIERS-TI, Port of Vancouver, Prince Rupert Port Authority

the share for the NWSA ports on a TEU basis dropped from 14.2% in 2005 to 7.9% in 2015 and to 7.3% in 2019.

Table 5 displays a ranking of the top imported commodities from Far Eastern countries to the Continental United States transiting in waterborne containers. As may be seen, imports are nearly all retail goods rather than raw materials or inputs to manufacturing. As such, the imports need to be distributed across the Continental USA. Even the auto parts commodity includes very little in the way of parts for vehicle assembly; instead, the lion's share of imports in this category are replacement parts moving into dealer networks and third-party auto parts retailers.

As shown in Table 6, importers may be classified into four broad groups: (1) small and regional importers, i.e., importers bringing in goods consumed solely within one region of the Continental USA, and/or small-scale importers, bringing in less than 200 TEUs per week; (2) large nation-wide importers of inexpensive goods, bringing in more than 200 TEUs per week of goods with average declared value less than $15,000 per TEU that are distributed across the Continental USA; (3) large nation-wide importers of inexpensive and moderate-value goods, bringing in more than 200 TEUs per week of goods with average declared valued values up to $40,000 per TEU that are distributed across the Continental USA; and (4) large nation-wide importers of expensive goods, bringing in more than 200 TEUs per week of goods with average declared value higher than $40,000 per TEU.

Category (4) importers develop supply chains to manage inventories as tightly as possible. This category predominantly consists of original equipment manufacturers (OEMs) who bring Asian-manufactured goods to the USA and then re-sell them to USA retailers, re-shipping the goods to regional distribution centers or retail outlets operated by the retail customers. This category includes electronics companies, footwear companies, tire companies, and the like. Onward landside shipment from a cross-dock or import warehouse in the vicinity of the port of entry is made in domestic trailers or containers; the ocean carriers are not involved in this transportation. The great majority of imports from Asia in this category enter the USA through the San Pedro Bay ports; a lesser amount enters through Puget Sound. Category (3) importers develop supply chains involving 2-5 ports of entry for the Continental USA, whereby marine containers are routed to cross-docks in the vicinity of the port of entry, the imported goods are sorted and re-stuffed into domestic containers and trailers that are dispatched to regional distribution centers or to an import warehouse (for goods not yet in demand). By de-vanning imports from marine containers and re-allocating them among regional distribution centers, Category (3) importers achieve a better match-up of supply with demand than otherwise. To a much lesser extent, Category (3) importers utilize IPI service, principally for one-time-sales items or for very low-value items. Large "Big-Box" retailers such as Walmart, Target, Home Depot, Lowe's, Family Dollar and others populate this category. In contrast, Category (2) importers develop supply chains to manage transportation costs as tightly as possible. Prominent members of this category are furniture retailers such as Ashley Furniture and Ikea. In these supply chains, marine boxes are routed directly from the source factories in the Far East to regional distribution centers across the Continental USA. Category (2) importers are major users of IPI services offered by the ocean carriers. Category (1) importers are too small in scope or scale to achieve any economies from the trans-loading practices of the Category (3) and (4) importers, and so they develop supply

Table 5
Top Commodities in Far East – USA Waterborne Containerized Imports in 2019

Commodity	**Share**
Furniture, Bedding, Lamps	16.8%
Machinery and computers	8.8%
Electronics, electrical equipment and electric appliances	8.2%
Toys, games and sports equipment	6.7%
Plastic products	6.7%
Apparel	5.2%
Auto parts and motorcycles	5.2%
Rubber products	4.3%
Steel products	3.8%
Footwear	3.2%
Linen, blankets, curtains	2.1%
Leather goods	2.0%
Paper products	1.9%
Wood products	1.9%
All other	23.2%

Source: PIERS-TI and GTA

Table 6
Classification of Importer Types

Category (1)	Small and regional importers
Category (2)	Large, nation-wide retailers whose products have low declared values, e.g., furniture retailers
Category (3)	Large, nation-wide retailers whose products averaging moderate declared values, e.g., Wal-Mart, Target, Home Depot, Lowe's, Amazon
Category (4)	Large, nation-wide retailers and OEMs of products with high-declared values, e.g., Samsung, LG

chains similar to those of Category (2) importers. Category (1) and (2) importers thus account for most of IPI traffic.

Table 7 displays a ranking of the top importers of waterborne, containerized imports from Far Eastern countries to the Continental United States in 2019. As may be seen, Big-Box retailers (Category 3), furniture retailers (Category 2) and original equipment manufacturers of electronics and electrical appliances (Category 4) dominate the list.

Waterborne, containerized imports via the NWSA ports destined to regions east of the Rockies move out of Washington almost entirely by rail. Trucking such long distances is much more expensive than rail and only marginally faster. The Elasticity Model's optimization calculations do not allocate any imports destined to regions east of the Rockies to truck movement. On the other hand, for imports to be consumed in the Pacific Northwest region (Washington, Oregon, Idaho and Montana), none move via rail, as no rail intermodal service is available.

Some IPI customers (typically very large importers) insist on a particular port of entry, but most leave it up to the carrier. IPI traffic not specifying a port of entry is termed "discretionary cargo" by the ocean carriers.

In 2005 the Ports of Seattle and Tacoma enjoyed strong IPI traffic, but subsequently IPI traffic at the NWSA ports declined sharply. Table 8 portrays trends in IPI traffic to USA points east of the Rockies during the period 2013-2019. As may be seen, total IPI traffic during this period declined by about 287,000 TEUs or 6.9%. IPI traffic via California ports declined about 465,000 TEUs or 15.6%, while IPI traffic via the Ports of Seattle and Tacoma declined about 240,000 TEUs or 34.9%. During the same period, IPI traffic to USA points east of the Rockies routed via British Columbia ports increased by about 418,000 TEUs or 82.9%.

Overall IPI traffic has declined steadily since 2005 for two major reasons. First, there has been increased and lower-priced all-water service offered to importers. Second, large Big-Box and E-commerce firms have taken retail market share away from small and regional retailers. As noted above, small and regional retailers rely on IPI service for their imports from the Far East, while large Big-Box and E-commerce retailers make only modest use of it.

One reason for the marked shift of IPI traffic to USA points to routings via the British Columbia ports is that imports destined to the USA routed via Canadian ports avoid the Harbor Maintenance Fee assessed at all USA ports. This fee is set at 0.125% of declared value, paid by the importer. In 2019, the average declared value of imports from Far East countries via the NWSA ports was about $38,400 per TEU.[8] The HMF on a commodity with this declared value would be about $48 per TEU. If instead shipments of this commodity were routed via a British Columbia port, the importer would save $48 per TEU.

A second reason for the growth of USA imports via the British Columbia ports is that the Canadian railroads charge the ocean carriers less than do the US railroads to certain inland US

[8] Source: PIERS-TI.

Table 7
Top Importers of Far East – USA Waterborne, Containerized Imports in 2019

Importer	Volume (TEUs)	Type of Company
Walmart	893.390	Big-box retailer (Category 3)
Target	600,040	Big-box retailer (Cat. 3)
Home Depot	400,100	Big-box home improvement (Cat. 3)
Lowe's	292,244	Big-box home improvement (Cat. 3)
Ashley Furniture	270,000	Furniture (Cat. 2)
Samsung	181,328	OEM of electronics, appliances (Cat. 4)
Family Dollar Stores/Dollar Tree	171,936	Big-box retailer (Cat. 3)
LG Group	156,348	OEM of electronics, appliances (Cat. 4)
IKEA	131,684	Furniture (Cat. 2)
Nike	118,219	OEM of footwear (Cat. 4)
Williams-Sonoma	88,800	Appliances (Cat. 3)
Rooms to Go	69,680	Furniture (Cat. 2)

Source: PIERS-TI

Table 8
IPI Traffic to USA Points East of the Rockies, 2013 - 2019 (TEUs)

Year	British Columbia Ports	NWSA Ports	California Ports	Total IPI
2013	504,035	688,112	2,972,921	4,165,068
2014	580,531	589,796	2,817,592	3,987,919
2015	694,273	564,274	2,855,520	4,114,067
2016	698,567	578,793	2,655,807	3,933,167
2017	799,440	485,920	2,747,909	4,033,269
2018	869,725	491,975	2,773,467	4,135,167
2019	921,796	448,188	2,507,927	3,877,911

Source: Intermodal Association of North America

points. Terms between ocean carriers and railroads are confidential contracts with complicated terms, but it is believed that the Canadian roads are charging the ocean carriers about $50 - $100 less per TEU to the Upper Midwest and the greater Chicago area than are the US railroads.[9] Contract IPI rates via Prince Rupert and Vancouver to the Twin Cities and Chicago from the ocean carriers for at least one large Category (3) importer are lower than the IPI rates it can obtain via USA ports.[10]

Rates charged for intermodal rail or truck movement of goods within the USA generally follow the following structure: there is a base rate, to which is added a "fuel recovery surcharge" (FRS) reflecting the change in average diesel fuel price since the date applicable to the base rate. The FRS is expressed as a percentage of the base rate. It is adjusted periodically according to average diesel fuel prices published by the Energy Information Administration of the Federal government.

In pre-pandemic years, the lion's share of waterborne containerized imports from the Far East to the USA moved under annual contract rates. Base rates were established in confidential contracts between importers and the carriers. They varied from importer to importer; large importers guaranteeing large, steady shipment volumes over the life of an annual contract were awarded low base rates; casual importers paid spot prices that at times were much higher.

Union Pacific and BNSF provide long-distance rail service connecting the NWSA ports with rail intermodal terminals located east of the Rockies, functioning as subcontractors to ocean carriers (imports in marine containers under IPI service) and to IMCs (imports trans-loaded to domestic containers or trailers). Northwest Container Services, Inc. provides short-haul rail movement of marine containers from the NWSA ports to Portland, OR, utilizing Union Pacific as a subcontractor.

The lion's share of waterborne, containerized imports through the NWSA ports that move landside by rail (either IPI or trans-loaded to domestic containers or trailers) end their rail movement in the greater Chicago area or are interchanged to eastern railroads in Chicago. The next largest share moves to the Minneapolis – St. Paul (Twin Cities) area. The third largest share moves to Portland. Very minor amounts move to other destinations such as Denver, Omaha and Kansas City, and are ignored in this analysis.

The following base rates for rail intermodal and for drays associated with trans-loading imports have been assumed in this analysis:

- IPI NWSA ports to Minneapolis (Midway intermodal terminal on BNSF): $1,400 per FEU
- IPI NWSA ports to Chicago (Logistics Park terminal on BNSF, Global 4 terminal on UP): $1,350 per FEU
- Dray marine container NWSA ports to Cross-dock or import warehouse in greater Puget Sound area: $185

[9] Private communications from BNSF and Union Pacific railroads.
[10] Private communications from a Big-Box retailer.

- Dray domestic container Cross-dock or import warehouse in greater Puget Sound area to TACSIM intermodal terminal (UP) or South Seattle intermodal terminal (BNSF): $185
- Domestic stack train service TACSIM or South Seattle to Chicago (Cicero terminal on BNSF, Global 2 terminal on UP): $1,400 per 53-foot container (1.5 FEUs)
- Domestic stack train service South Seattle to Minneapolis (Midway terminal): $1,200 per 53-foot container (1.5 FEUs)

It may seem strange that the IPI rate to Chicago is higher than the IPI rate to Minneapolis, but this reflects BNSF's monopoly power in the Twin Cities market. It also may seem strange that rates on a per-TEU basis are much cheaper for domestic containers; this reflects the strong contract leverage railroads have with ocean carriers vs. the weaker leverage they have with intermodal marketing companies, as well as the need to be competitive with trucking for domestic (not import) freight moving under the same IMC rates.

In 2015, FRS percentages were 22.5% for trucking and 28.5% for rail intermodal. Since then, they have risen considerably. It is of course difficult to predict future diesel prices. For the purposes of this analysis, FRS percentages of 34.5% for dray and 40.5% for rail intermodal movement are assumed, about where they were before the start of the Ukraine War.

Application of the potential PUT to interstate rail shipments on a pro-rated-mileage basis requires knowledge of the within-Washington and outside-Washington mileages in the overall haul. The two railroads (UP and BNSF) follow different routes with different mileages. They use different terminals in the NWSA vicinity and different terminals in the greater Chicago area.

From Puget Sound, Union Pacific has only one route out of Washington, proceeding southward to exit the State at Vancouver before turning east along the Oregon side of the Columbia River.

BNSF operates three routes from the Puget Sound area across Washington State that converge at Spokane: (1) North to Everett and then east over Stevens Pass, through Wenatchee to Spokane; (2) East from Auburn over Stampede Pass, following the Yakima River to Pasco and then northeastward to Spokane; and (3) South to Vancouver and then east on a water grade through the Columbia River Gorge, joining the Stampede Pass route at Pasco. Tunnels on Stampede Pass do not clear double-stacked containers, so BNSF intermodal trains must use the Stevens Pass or Columbia Gorge routes. The Stevens Pass route is the shortest but does not have enough track capacity to efficiently accommodate all BNSF intermodal traffic. It also is much more steeply graded than the Columbia Gorge route.

East of Sandpoint, Idaho, BNSF operates three routes to Chicago: (1) The so-called Hi-Line via Havre, MT, Minot, ND, Fargo, ND, and the Twin Cities; (2) A route across southern Montana through Missoula and Billings, Bismarck, ND, and joining the Hi-Line route shortly before reaching Fargo; and (3) Branching off from the southern Montana route just east of Billings, heading southeastward through the Powder River Basin coal fields of Wyoming, across Nebraska and Southern Iowa and through Galesburg, IL, en route to Chicago. The Hi-Line route is the shortest but has limited track capacity.

Domestic-box intermodal trains handle UPS, Fed Ex and less-than-truckload (LTL) carrier shipments that are time sensitive, as well as other time-sensitive shipments such as Washington wine and perishables. Normally, BNSF domestic-box intermodal trains to Minneapolis and Chicago from South Seattle operate via Stevens Pass and the Hi Line. In contrast, BNSF marine-box stack trains to those points are normally routed via the Columbia Gorge, up to Spokane, and then via the Hi Line east of Sandpoint.

Some IPI trains originate at "on-dock" terminals in Tacoma; others originate at the off-dock terminals Seattle International Gateway (SIG) operated by BNSF and Argo operated by Union Pacific. The share of volume by origin depends on market shares for ocean carriers and which railroad successfully contracted with each ocean carrier to handle IPI traffic. Similarly, railroad shares of domestic-box (trans-loaded) traffic depend on IMC market shares, as well as on which railroad successfully contracted with each IMC for domestic-box traffic. The following shares are assumed in this analysis:

Domestic-box traffic to Chicago: BNSF 70%, UP 30%
Domestic-box traffic to Minneapolis: BNSF 100%, UP 0%
IPI traffic to Chicago: BNSF 65%, UP 35%
IPI traffic to Minneapolis: BNSF 100%, UP 0%
UP IPI traffic: 75% Argo, 25% Tacoma on-dock
BNSF IPI traffic: 25% SIG, 75% Tacoma on-dock

At times, BNSF intermodal trains have been shifted to alternate routes. When Bakken oil movements were heavy, or because of weather disruptions or derailments, intermodal trains to the Twin Cities and Chicago have taken the southern Montana route. Marine-box (IPI) trains to Chicago also have been re-routed via the Powder River Basin route. The less-time-sensitive marine-box trains are much more susceptible to re-routing than the domestic-box trains, but there have been instances when domestic-box intermodal trains were re-routed.

The normally-used routes for intermodal trains use have the following mileages inside and outside Washington State:

UP marine-box (IPI) trains Argo terminal – Global 4 in Chicago: 171.3 Washington miles, 2408.4 total miles, 7.1% Washington miles. Effective tax: $1,350*(1.405)*(0.0711)*(0.01926) = $2.60 per FEU
UP marine-box (IPI) trains Tacoma on-dock – Global 4 in Chicago: 141.7 Washington miles, 2,378.8 total miles, 5.96% Washington miles. Effective tax: $1,350*(1.405)*(0.0596)*(0.01926) = $2.18 per FEU
UP domestic-box trains Tacoma South Intermodal (TACSIM) to Global 2 in Chicago: 141.8 Washington miles, 2360.1 total miles, 6.01% Washington miles. Effective tax: $1,400*(1.405)*(0.0601)*(0.01926) = $2.28 per 53-foot container (1.5 FEUs)

BNSF IPI trains Seattle International Gateway (SIG) – Logistics Park in Chicago: 554.7 Washington miles, 2503.8 total miles, 22.15% Washington miles. Effective tax: $1,350*(1.405)*(0.2215)*(0.01926) = $8.09 per FEU

BNSF IPI trains Tacoma on-dock – Logistics Park in Chicago: 520.9 Washington miles, 2,470.0 total miles, 21.09% Washington miles. Effective tax: $1,350*(1.405)*(0.2109)*(0.01926) = $7.70 per FEU
BNSF domestic-box trains South Seattle – Cicero terminal in Chicago: 350.6 Washington miles, 2,207.0 total miles, 15.89% Washington miles. Effective tax:
$1,400*(1.405)*(0.1589)*(0.01926) = $6.02 per 53-foot container (1.5 FEUs)
BNSF IPI trains SIG – Midway terminal in Minneapolis: 554.7 Washington miles, 1,971.6 total miles, 28.13% Washington miles. Effective tax: $1,400*(1.405)*(0.2813)*(0.01926) = $10.66 per FEU
BNSF IPI trains Tacoma on-dock Midway terminal in Minneapolis: 520.9 Washington miles, 1,937.8 total miles, 26.88% Washington miles. Effective tax:
$1,400*(1.405)*(0.2688)*(0.01926) = $10.18 per FEU
BNSF domestic-box trains South Seattle – Midway terminal in Minneapolis: 350.6 Washington miles, 1,767.5 total miles, 19.84% Washington miles. Effective tax:
$1,200*(1.405)*(0.1984)*(0.01926) = $6.44 per 53-foot container (1.5 FEUs)

Alternate BNSF routes for marine-box trains east of Sandpoint have the following mileages:

BNSF IPI trains SIG – Logistics Park in Chicago via the southern Montana route: 554.7 Washington miles, 2,591.7 total miles, 21.40% Washington miles. Effective tax:
$1,350*(1.405)*(0.2140)*(0.01926) = $7.82 per FEU
BNSF trains Tacoma on-dock – Logistics Park in Chicago via the southern Montana route: 520.9 Washington miles, 2,557.9 total miles, 20.36% Washington miles. Effective tax:
$1,350*(1.405)*(0.2036)*(0.01926) = $7.44 per FEU
BNSF IPI trains SIG –Logistics Park in Chicago via the Powder River Basin route: 554.7 Washington miles, 2,527.0 total miles, 21.95% Washington miles. Effective tax:
$1,350*(1.405)*(0.2195)*(0.01926) = $8.02 per FEU
BNSF trains Tacoma on-dock – Logistics Park in Chicago via the Powder River Basin route: 520.9 Washington miles, 2,493.2 total miles, 20.89% Washington miles. Effective tax:
$1,350*(1.405)*(0.2089)*(0.01926) = $7.63 per FEU

For the purposes of this analysis, the mileages in the primary, normal routes utilized by marine-box and domestic box intermodal trains are considered, and alternate routes are ignored.

The Elasticity Model includes separate input parameters for dray costs to IPI and domestic-box rail terminals within a port area, but it does not admit parameters for rail costs for alternative IPI rail terminals or for alternative domestic-box rail terminals for the same port area. The Model also does not admit different parameters for rail costs for alternative IPI channels or alternative domestic-box channels between the same origin-destination pair. Weighted-average rates are required to be input to the Model. For IPI traffic to points other than Minneapolis, the weighted-average increment associated with the PUT on the normal, primary routes is calculated as (0.65)(0.25)($8.09) + (0.65)(0.75)($7.70) + (0.35)(0.75)($2.60) + (0.35)(0.25)($2.18) = $5.94 per FEU. For domestic-box traffic to points other than Minneapolis, the weighted-average increment is calculated as (0.7)($6.02) + (0.3)($2.28) = $4.90 per 53-foot container (1.5 FEUs). For IPI traffic to Minneapolis, the weighted-average increment is calculated as (0.25)($10.66) +

(0.75)($10.18) = $10.30 per FEU. For domestic-box traffic to Minneapolis, there is only one channel, with a PUT supplement of $6.44 per 53-foot container (1.5 FEUs) on the rail cost.

For trans-loaded imports, costs for drays of marine boxes from marine terminals to cross-docks or import warehouses in the hinterland of the NWSA Ports and for drays of the domestic containers from cross-docks or import warehouses to the domestic-box rail terminals are included in the analysis. Dray rates vary depending on the particular marine terminal, the location of the cross-dock or import warehouse, and which railroad is used. The assumed average base rates for these drays are as follows:[11]

Dray marine container from marine terminals to cross-dock or import warehouse: $200 per FEU
Dray domestic container from cross-dock or import warehouse to BNSF South Seattle terminal: $200 per 53-foot container (1.5 FEUs)
Dray domestic container from cross-dock or import warehouse to UP TACSIM terminal: $150 per 53-foot container (1.5 FEUs)

Considering the assumed trucking FRS and the assumed market shares for BNSF and UP, the PUT increments on these dray trips are as follows:

Dray marine container from marine terminals to cross-dock or import warehouse:
$200*(1.345)*(0.01926) = $5.18 per FEU
Dray domestic container from cross-dock or import warehouse to domestic rail terminal:
(0.7)*($200)(1.345)(0.01926) + (0.3)*($150)(1.345)(0.01926) = $4.79 if Chicago destination, $5.18 if Minneapolis destination, per 53-foot container (1.5 FEUs)

Note that, because of the off-port drays required, the potential PUT has a somewhat greater overall financial impact on trans-loaded imports despite a smaller collection of PUT on the rail movement portion.

I computed import flows using the Elasticity Model once with the base-case data and then a second time assuming the foregoing PUT supplements on rates paid by the importers for their imports routed through the Ports of Seattle and Tacoma.

Table 9 compares the port shares of Far East – Continental USA containerized imports calculated by Elasticity Model for the base-case 2019 data to the actual shares reported in the PIERS-TI extract of US Customs data for 2019. The match is not perfect, but it is reasonably close in view of the Model's purpose to predict changes in port and channel shares as a result of changes in port and channel economics.

Table 10 displays the port shares for Elasticity Model calculations on the Base Case. The Base Case calculation of the Elasticity Model predicts a 2019 Far East import volume at the NWSA ports of approximately 1,390,100 TEUs for a 9.2% share of Far East – Continental USA containerized imports. A re-run of the calculations of the Elasticity Model with the PUT added resulted in a minor drop of about 2,200 TEUs about 0.16% of total Far East – USA waterborne,

[11] These rates are based on private communications from large Category (3) importers.

Table 9
Comparison of 2019 Actual Port Shares of Far East - USA Containerized Imports to Base-Case Elasticity Model Calculations

Port of Entry	2019 Actual	Elasticity Model
All-water (Gulf Coast and East Coast)	37.8%	36.7%
San Pedro Bay	45.3%	45.3%
Oakland	4.2%	2.5%
NWSA Ports	7.3%	9.2%
British Columbia Ports	5.3%	6.3%

Sources: PIERS-TI for actual shares and author's Elasticity Model calculations

Table 10
Calculated Port Shares of Far East - USA Containerized Imports (TEU basis)

Port of Entry	Base Case	PUT Supplement
All-water	36.7%	36.7%
San Pedro Bay	45.3%	45.3%
Oakland	2.5%	2.5%
NWSA Ports	9.2%	9.2%
British Columbia Ports	6.3%	6.3%

Source: Author's Elasticity Model calculations

containerized imports. This drop consisted entirely of trans-loaded traffic shifted to enter the USA via the San Pedro Bay ports instead of the NWSA ports.

To test the sensitivity of import volumes via the NWSA ports to a PUT-type tax, the 0.01926% mileage-prorated tax was scaled upwards. Results are displayed in Figures 5 and 6. As seen in Figure 5, if the PUT rate were doubled ("2X PUT"), import diversions more than double, rising to 5,600 TEUs per year. Scaling the tax rate further does not result in further diversions until the tax rate is scaled seven times, at which point, diversions rise sharply, reaching more than 13,000 TEUs per year. For extreme tax rates, diversions increase dramatically, as depicted in Figure 6. A 10X PUT results in a loss of about 300,000 TEUs of imports; a 20X PUT results in a loss of about 475,000 TEUs; and a 50X PUT results in a loss of more than 560,000 TEUs or more than 40% of NWSA import volume.

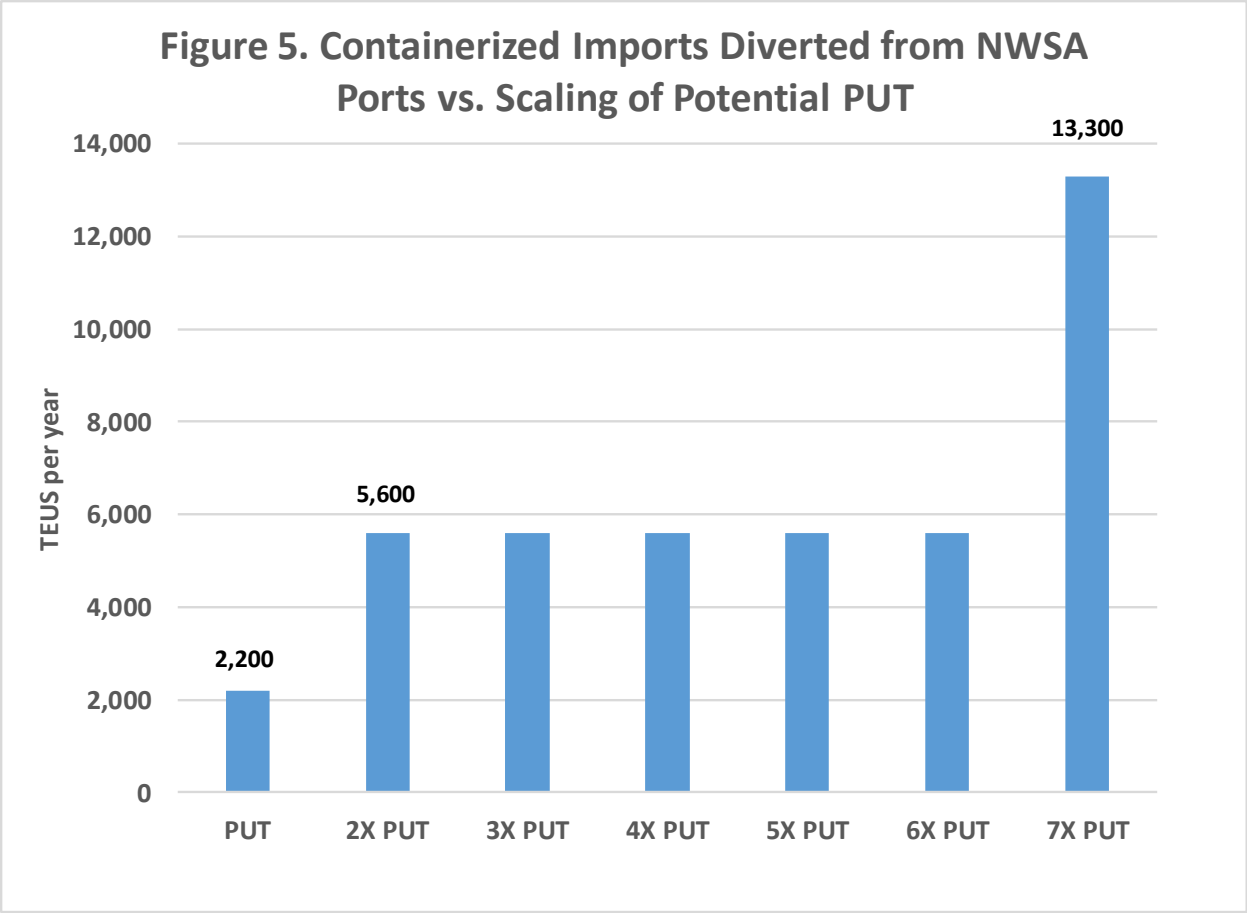
Figure 5. Containerized Imports Diverted from NWSA Ports vs. Scaling of Potential PUT
TEUS per year
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2,200
5,600
13,300
PUT
2X PUT
3X PUT
4X PUT
5X PUT
6X PUT
7X PUT

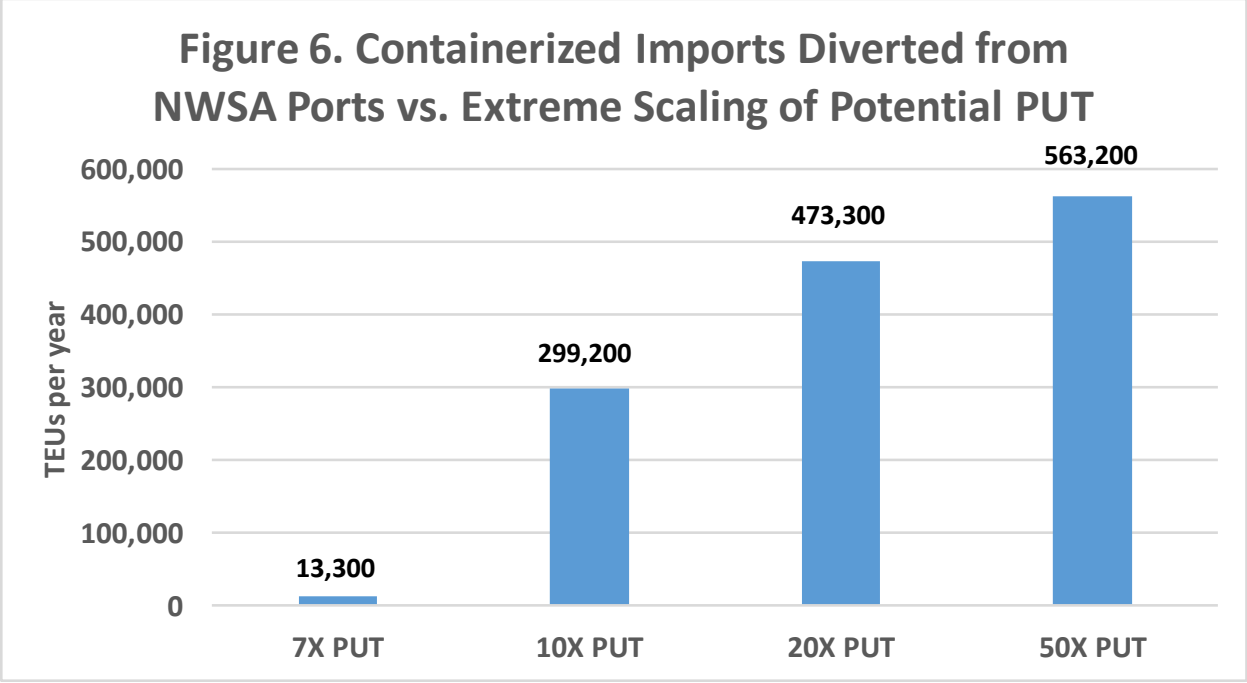
Figure 6. Containerized Imports Diverted from NWSA Ports vs. Extreme Scaling of Potential PUT
TEUs per year
600,000
500,000
400,000
300,000
200,000
100,000
0
13,300
299,200
473,300
563,200
7X PUT
10X PUT
20X PUT
50X PUT

To put the proposed PUT in perspective, a Category (1) or (2) importer bringing goods from a port city in China to a distribution center located in the greater Chicago area will spend about $4,700 per high-cube 40-foot container on IPI-channel transportation ($2,500 for Far East dray and cross-Pacific vessel movement, $1,900 for inland rail movement, and $300 for destination dray). If the declared value of the imported goods is $77,800 per FEU (the 2019 average for Far East imports at the NWSA ports), the importer pays an additional $96 for the Harbor Maintenance Fee, making for a total cost of $4,796 or about $4,800. A surcharge of about $4.60 per FEU (IPI) to cover the potential Washington PUT amounts to less than a 0.1% increase in import shipping costs.[12] A Category (3) or (4) importer practicing a trans-loading supply chain would pay slightly more PUT because of the drays within Washington to/from cross-docks or import warehouses in the hinterland of the NWSA ports, but still a very small percentage tacked on to the total shipping cost.

Reviewing the Model calculations in more detail, in both the Base-Case and the PUT Supplement scenarios, 48.8% of the import volume at the Puget Sound ports consists of goods imported by Category (1), Category (2) and Category (3) importers to be consumed in the region local to the NWSA ports. This region includes the states of Washington, Oregon, Idaho and Montana. The remaining 51.2% of imports at the NWSA ports are accounted for by goods to be consumed in regions east of the Rockies, mostly imported by Category (3) importers de-vanning marine boxes in the hinterland of the ports are re-shipping in domestic containers and trailers.

Category (3) importers bringing imports through the NWSA ports to be ultimately consumed east of the Rockies trans-load their goods to domestic containers hauled in domestic-box intermodal trains by the railroads. Inventory economies are achieved by the large retailers in this category through the pooling of demands in the Pacific Northwest, Upper Midwest and Chicago regions, re-allocating imports after arrival at Puget Sound so as to better match up supply and demand in the several regions, reacting to fluctuations in demands transpiring subsequent to booking vessel passage from the Far East.

Rates for domestic containers reflect the east-west balance of demand for the domestic containers. At present, westbound is the head-haul to the Puget Sound area for domestic containers, but eastbound is the head-haul from California and from Vancouver. Because of a complete lack of westbound domestic-stack business, eastbound domestic-stack train service is not available from Prince Rupert. Domestic-box rail rates from Seattle and Tacoma to selected inland points such as the Twin Cities and Chicago are attractive to Category (3) importers. Shifting these imports to use Vancouver or California ports as the North American port of entry would entail a substantial increase in costs for such importers. Their imports are relatively insensitive to the modest potential PUT analyzed here. However, if scaled up enough, the tax could drive a substantial amount of Category (2), (3) and (4) import volume away from the NWSA ports, as shown in Figures 5 and 6.

Let us now consider the impact of the potential PUT on imports ultimately consumed in the Pacific Northwest region that are routed through the NWSA ports. The Elasticity Model

[12] The importer typically would not know the breakdown provided here and instead would be quoted a $4,300 rate including all dray, rail and ocean vessel transport door-to-door.

calculations showed no diversion of such imports to other ports, even at high multiples of the potential PUT. This can be understood as follows.

As noted above, the vast majority of imports from the Far East through the NWSA ports are retail goods, or goods that will become retail goods after minor value-added operations and/or re-sale. Marine containers containing such imports destined to the region local to Puget Sound by and large are not routed directly to retail outlets. Instead, they are routed to regional distribution centers or import warehouses operated by or on behalf of large retailers. Inventory is held at such facilities until inventories at retail outlets warrant replenishment, at which time domestic trucking is used to make replenishment.

The regional distribution centers (RDCs) and import warehouses for all large American retailers serving the greater Pacific Northwest region (Washington, Oregon, Idaho, Montana) are located west of the Cascades. This is done because most of their retail sales occur west of the Cascades; locating further east would entail much wasted transportation from ports of entry to warehouses and back to retail outlets west of the Cascades, as well as extra time in transit. Most such RDCs and import warehouses are located in the south end of the Kent Valley or in new warehouse parks around Tacoma (e.g., Frederickson) and Olympia (e.g., Lacey); some are located further south, a few as far south as Oregon's Willamette Valley. The point is, the destinations for import marine containers imported through Puget Sound containing goods to be consumed in the Pacific Northwest are quite concentrated. Very few loaded import containers make their way east of the Cascades.

Trucking a forty-foot marine container down from the Port of Vancouver or up from Portland to a warehouse located in the Kent Valley or greater Tacoma area costs on the order of $400-$600, compared to $100-$200 for a dray from the Ports of Tacoma and Seattle. Trucking a container from the California ports to these distribution centers would cost much more. Given the trucking distances involved, the potential PUT makes this trade-off more favorable to the NWSA ports, not less.

The Port of Portland has, at present, once-weekly container vessel service. Vessel size is limited by the channel depth of the Columbia River to smaller, less cost-effective vessels. Portland thus offers limited attractiveness to ocean carriers. The single service now there is justified on the basis of returning to the Far East with exports, and one vessel string is probably sufficient for the available export market at Portland.

As noted above, Northwest Container Services offers marine-container rail intermodal service between the NWSA ports and Portland, using Union Pacific as a subcontractor. The potential PUT could make this service more expensive, perhaps adding on the order of $4 to a $200 haul. However, service options for importers and exporters are very limited. I believe the impacts on the volume this service handles from such a minor cost increases would be very minor, if any.

A small volume of marine containers is handled on Columbia and Snake River barges between Portland and the Tri-Cities area and Lewiston, ID. Again this service is largely driven by the export market; I suspect most eastbound containers in this service are empty. It is not clear how much Washington pro-rated mileage would apply to barge movements in the Columbia River. In

any case, this volume is very small, and so impacts of the potential PUT also would be very small, if any.

One might wonder if the potential PUT would induce some retailers to re-locate their RDCs or import warehouses from Washington to Oregon. This could avoid the PUT for distribution to retail outlets located in Oregon or Southern Idaho. However, it would increase the PUT for distribution to retail outlets in the Puget Sound area and northern Washington. Given the much larger population in Western Washington than in Oregon plus Southern Idaho, this is not a favorable trade-off.

Considering the foregoing factors, the aggregate impact on imports consumed in the Pacific Northwest from the potential PUT would be very minor if any, much less than 1%.

In summary, the potential PUT of 1.926% applied to the Washington pro-rated mileage of rail and truck transport of waterborne, containerized imports would engender very minor diversion of imports handled through the NWSA ports. Calculations of the Elasticity Model suggest a diversion of only 2,200 TEUs per year destined to other regions, 0.16% of the 1.39 million TEUs of imports passing through the NWSA ports in 2019. Further calculations of the Model predict that a doubling of the potential PUT would result in a diversion of 5,600 TEUs per year, still a very small fraction. For imports consumed within the Pacific Northwest, the potential PUT would increase the cost penalty of routing Far East imports destined to the Pacific Northwest via ports other than the NWSA ports, so diversion of imports consumed within the region is not a concern.

Uncertainty and Limitations

The reaction of importers to very small changes in logistics costs is variable, both in scope and timing. There are considerable costs and delays associated with re-structuring supply chains: Closing warehouses and opening new ones, ending long-term transportation contracts and securing new long-term contracts, re-positioning equipment and staff, etc. These things may delay changes management decides to pursue for a year or more. Or changes to supply chains may be rejected or deferred because the one-time costs of re-structuring may be perceived as too much in exchange for very modest, recurring operational cost savings.

As discussed earlier, during the pandemic 2020-2022 supply chains were radically re-structured, arguably more out of desperation than any long-term considerations. As of the start of 2023, port congestion has eased and trans-Pacific prices have dropped, so I expect supply chains this year to begin shifting back to their pre-pandemic patterns. However, a resurgence of the pandemic, or other major disruptions such as a West Coast dockworkers strike, could dramatically change the volume and composition of imports at the NWSA ports from that assumed herein.

Given how small the potential PUT is, I don’t think there is much cause for concern. It is just too small of an increment in logistics costs to have much of an effect.

Operational Concerns

The use of alternative rail routes by BNSF as required by its traffic and maintenance activity levels raises concerns about the correct administration of a PUT based on pro-rated mileage: (1) Is it practical to consider the specific terminals and specific route taken by each intermodal train movement in order to compute and assess the PUT? (2) Is it reasonable that the amount of PUT Washington collects is reduced when BNSF re-routes one of its intermodal trains via a longer alternate route east of Sandpoint, ID? (3) Is it reasonable that Washington collects more PUT when BNSF routes intermodal trains through the Columbia Gorge instead of over Stevens Pass? (4) If PUT is to be assessed based on pro-rating the actual train mileage, how will honest reporting by the railroads be ensured? Who will police and audit BNSF reporting of miles hauled?

This issue is outside the scope of this report, but perhaps it deserves attention in order to formulate a practical proposal for a PUT on rail movement of imported goods.