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# Container Drayage Disruptions in Port Cities: A Global Analysis

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# Port Container Drayage: Disruptions and Interventions in Port Cities

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ABSTRACT

This paper analyses the determinants of port container drayage disruptions, interventions, and the overarching governance models which organize these events. We focus on the urban context within which these disruptions, interventions and governance models exist by limiting our scope to port cities. Using a dataset categorizing different types of regulatory interventions and freight disruptions, we quantify the relationship between interventions and disruptions while controlling for economic indicators and urban contexts. We also find different forms of port governance are insignificant to likelihood of a disruptions, but types of policies are.

<u>Note:</u>

This project is in development and will evolve and change by the time of the presentation. Many details were omitted for the sake of brevity.

# INTRODUCTION

Port container drayage may be defined as the transportation by motor truck of containers to and from marine terminals over relatively short distances. Typically, drayage occurs within the metropolitan region hosting both the port facility and the inland point of origin/destination, whether the latter is a warehouse, distribution center, storage yard, or an intermodal rail terminal. Efficient truck operations are important for marine terminal efficiency, especially given the increasing average ship size in the container fleet and the consolidation of loads. Port trucking is also a flashpoint for conflict between community and government stakeholders, and marine carrier and terminal operators over the negative externalities (which are typically spatially concentrated) associated with truck operations. Port trucking is also vulnerable to disruption due to labor disputes, lack of equipment and unrelated disruptions in the surface transportation network. The decentralized and highly competitive market structure of drayage trucking, as well as its poorly understood status amongst decision-makers and their publics, is a barrier to effective interventions that may internalize the negative externalities. Nevertheless, the list of experimental interventions is growing; these range from licensing, appointments/reservations systems, and application of information systems, equipment upgrades, time-based pricing strategies to shift demand, changes to employment arrangements, infrastructural solutions, to planning-based approaches. We ask the following questions in our research:

- What are the urban contexts in which port container drayage disruptions have occurred?
- What is the type of port container trucking industry interventions that cause a greater number of disruptions?
- How are these interventions organized into overarching governance models?
- What is the combined effect of urban context and governance models on these events?

## DATA

For 106 major container ports, with representation on every populated continent, we have identified over 1,000 instances of port drayage disruption and governance interventions. These data have then been used to describe patterns of port container trucking interventions, and create a typology of these that define an initial set of policy structures and governance models.

In addition to the information on each intervention and disruption, we have data to describe the broader economic and urban context. This includes national Gross Domestic Product (GDP), GDP per capita, and population. We also use agglomeration level data on the throughput of goods at a port in twenty-foot equivalent units (TEU) and urban population. All economic variables were scaled to millions to allow for easier interpretation. To account for different governance structures, we have binary variables for whether a city, country, state, or private entity serves as the administrator of the port.

Finally, to account for the regional competition and relevance of different ports, we have generated a modified Relative Concentration Index (RCI) as seen in Vallega (1979) and Ducuret and Lee (2006). We modify it by accounting for the urban concentration relative to other port cities in the region instead of all cities as it was previously defined. We compute this variable by dividing the percentage of regional TEUs that come from the port by the percentage of regional port urban population that is comes from the port. The equation is as follows:

$$RCI = \frac{TEU(Port)/TEU(Region)}{Urban\ Population(Port)/Urban\ Population(Ports\ in\ Region)}$$

This variable allows us to contextualize the port-city relationship. Smaller values imply that TEU primarily comes from being a large population center. Larger numbers imply a port is serving more than its urban area. While this variable is not easily interpreted, it is a necessary control when analyzing events (disruptions and interventions) that are as intertwined with globalization.

All observations have been binned into five year periods. We have a dummy variable for whether a disruption occurred during the time bins and another for if an intervention occurred. We also use lagged information from the previous time period in our analysis. For many of our economic variables we logged or squared the variable to account for non-linear relationships.

## RESULTS

Our preliminary findings indicated a correlation between disruptions and interventions. We can see the events in our dataset over time in Figure 1 of the appendix. To further explore this relationship and answer our research questions we ran several logistic regressions with a disruption dummy variable as our dependent variable. The results of the regressions can be seen in Table 1 and 2 of the appendix. The results require some discussion.

Our models in Table 1 primarily served to establish a basis for our economic controls. In all our models except the time fixed effects and intervention models we see that an increase in throughput decreases the likelihood of disruptions. However, the relationship inverts when we account for period specific phenomena with increases in TEUs correlating to increased likelihood of disruptions. Since we see dramatic increases in the predictive power and overall significance of our model when we control for these time fixed effects, throughput likely increases with the likelihood of a disruption. This conclusion is dependent on the assumption that there are global trends of disruptions over time. It is also important to note that the natural log of TEU is a significant variable in at least a 90% confidence interval in all of our models.

Urban population also faces a dramatic shift when implementing time fixed effects. We see both an inversion of the relationship and an elimination of significance for both the linear and quadratic term. Before implementing the time fixed effects we see that urban population increases disruptions to a turning point approximately at 20,000 people. Most port cities pass this critical point and thus an increase in urban population increases the likelihood of a disruption exponentially. This effect likely inverts and becomes insignificant with the time fixed effects because of the global increase in urban population over time. Since the time dummy variables are significant and negative, it is likely still true that increase in urban population causes an increase in disruptions, but the effect is drowned out in the time trend.

The rest of the variables in Table 1 will not be interpreted for the sake of brevity, but still serve as controls for the more complex models in Table 2. This limits discussion on development of a ports country and causality of disruptions, but these themes will be discussed in the presentation and final paper. In Table 2 we see that once controlling for regional and time fixed effects, the type of governing body for the port has no effect on disruptions. We do see however that interventions of all kinds increase the likelihood of one, albeit with different magnitudes of likelihood. These results indicate that the correlation between interventions and disruptions we see in Figure 1 holds even with proper controls and fixed effects.

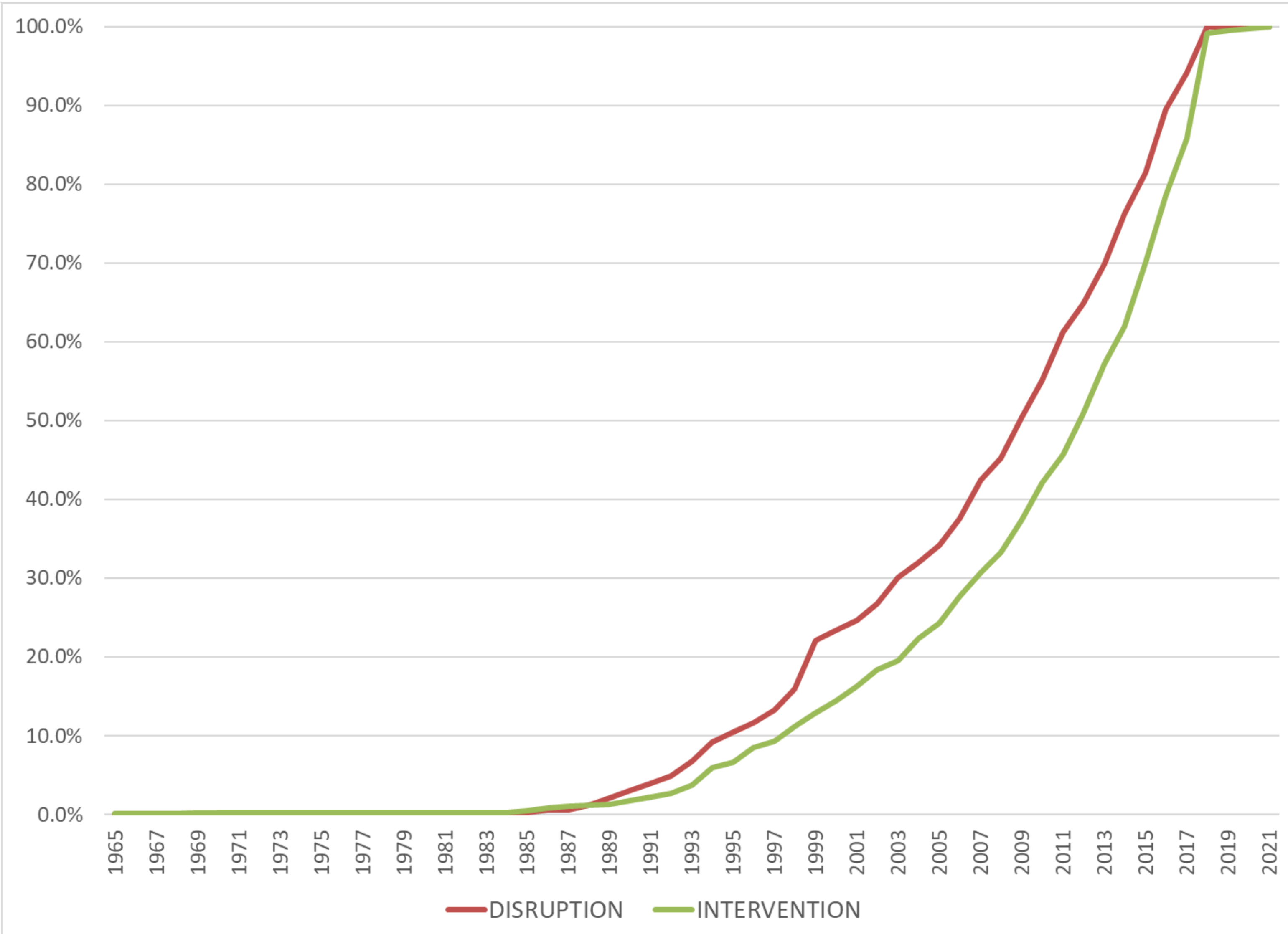
While regional fixed effects were omitted from the appendix, there are a few regions that were statistically significant in our analysis. African ports were the only region with an increase in likelihood of disruptions. Ports in East Coast North America, Northwest Europe, Australia, China, and East Coast Latin America all had on average decreases in likelihood of disruptions.

CONCLUSION

Regulatory interventions, large urban population, and port throughput growth are more likely to occur in periods with several port freight disruptions. The exact causality of these relationships is not covered in this summary and requires further analysis. While the type of governing body of a port doesn’t affect the likelihood of disruptions, the type of regulatory interventions implemented in that period does.

APPENDIX

Figure 1:



<u>Table 1</u>

| Model: | Urban Context | | Urban and National 1 | | Urban and National 2 | | Regional Context | |
|---|---|---|---|---|---|---|---|---|
| | Coefficient | P-Value | Coefficient | P-Value | Coefficient | P-Value | Coefficient | P-Value |
| Variable Name | | | | | | | | |
| Log(TEU) | -0.150 | 0.063 | -0.243 | 0.012 | -0.270 | 0.009 | -0.233 | 0.048 |
| Urban Population | 146.531 | 0.006 | 178.127 | 0.003 | 184.442 | 0.003 | 172.002 | 0.008 |
| (Urban Population)^2 | -3166.795 | 0.088 | -4959.348 | 0.015 | -5139.349 | 0.013 | -4897.671 | 0.020 |
| GDP per capita | | | 120.084 | 0.000 | 42.780 | 0.563 | 42.054 | 0.569 |
| (GDP per capita)^2 | | | -1408.539 | 0.034 | -512.927 | 0.629 | -449.510 | 0.673 |
| Log(National Population) | | | 0.064 | 0.974 | 1.198 | 0.551 | 1.194 | 0.557 |
| Log(National Population from prev. period) | | | 0.074 | 0.968 | -1.391 | 0.499 | -1.380 | 0.508 |
| Log(GDP) | | | | | -1.051 | 0.092 | -1.024 | 0.101 |
| Log(GDP from prev. period) | | | | | 1.462 | 0.020 | 1.420 | 0.024 |
| Relative Concentration Index | | | | | | | -0.030 | 0.552 |
| Constant | -0.140 | 0.895 | -2.781 | 0.218 | -6.324 | 0.121 | -6.451 | 0.114 |
| Classification Percentage Correct / R^2 | 83.500 | 0.050 | 83.700 | 0.207 | 83.500 | 0.226 | 83.500 | 0.227 |

Table 2:

| Model: | Governance Models | | Regional FE | | Time FE | | Intervention | | Intervention Types | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable Name | | | | | | | | | | |
| Log(TEU) | -0.302 | 0.021 | -0.378 | 0.014 | 0.790 | 0.012 | 0.945 | 0.008 | 1.162 | 0.009 |
| Urb Pop | 185.068 | 0.006 | 195.977 | 0.011 | -50.534 | 0.611 | -42.183 | 0.703 | -25.602 | 0.842 |
| (Urb Pop)^2 | -5050.382 | 0.022 | -5892.700 | 0.016 | -362.703 | 0.893 | -673.353 | 0.826 | -634.005 | 0.861 |
| GDP per capita | 80.833 | 0.289 | 135.061 | 0.115 | 63.967 | 0.521 | 68.933 | 0.533 | 175.822 | 0.182 |
| (GDP per cap)^2 | -908.258 | 0.409 | -1856.143 | 0.130 | -1914.010 | 0.176 | -2823.920 | 0.072 | -5845.054 | 0.004 |
| Log(Nat Pop) | -0.922 | 0.678 | -5.213 | 0.239 | 3.279 | 0.441 | 1.506 | 0.748 | 0.174 | 0.980 |
| Log(Nat Pop lag) | 0.886 | 0.697 | 5.040 | 0.261 | -3.239 | 0.449 | -1.301 | 0.782 | 0.508 | 0.940 |
| Log(GDP) | -1.245 | 0.055 | -0.835 | 0.212 | -0.623 | 0.496 | -1.676 | 0.092 | -2.312 | 0.052 |
| Log(GDP lag) | 1.507 | 0.021 | 1.367 | 0.045 | 0.737 | 0.404 | 1.554 | 0.114 | 2.107 | 0.071 |
| RCI | -0.029 | 0.623 | 0.005 | 0.938 | -0.365 | 0.023 | -0.469 | 0.011 | -0.453 | 0.032 |
| Municipality | -1.142 | 0.036 | -0.946 | 0.102 | -0.788 | 0.206 | -0.688 | 0.339 | -1.135 | 0.181 |
| State | -0.079 | 0.887 | 0.284 | 0.683 | 1.211 | 0.117 | 1.506 | 0.094 | 0.572 | 0.562 |
| Nation | -0.144 | 0.786 | -0.189 | 0.744 | -1.050 | 0.107 | -0.997 | 0.190 | -1.106 | 0.197 |
| Private Entity | -1.899 | 0.008 | -1.174 | 0.138 | -1.337 | 0.120 | -1.043 | 0.260 | -1.466 | 0.169 |
| 1978-1982 | | | | | -23.826 | 0.996 | -23.907 | 0.996 | -25.298 | 0.995 |
| 1983-1987 | | | | | -7.183 | 0.000 | -7.552 | 0.000 | -8.878 | 0.000 |
| 1988-1992 | | | | | -4.891 | 0.000 | -5.134 | 0.000 | -6.342 | 0.000 |
| 1993-1997 | | | | | -3.459 | 0.000 | -3.753 | 0.000 | -4.762 | 0.000 |
| 1998-2002 | | | | | -2.158 | 0.005 | -2.741 | 0.001 | -3.549 | 0.001 |
| 2003-2007 | | | | | -1.676 | 0.003 | -2.119 | 0.001 | -2.221 | 0.004 |
| Intervention | | | | | | | 2.691 | 0.000 | 0.893 | 0.238 |
| Total Hinterland | | | | | | | | | 1.586 | 0.006 |
| Total Land Use | | | | | | | | | 2.247 | 0.012 |
| Total Mode Sys. | | | | | | | | | -0.601 | 0.289 |
| Total Planning | | | | | | | | | 3.627 | 0.009 |
| Total Pricing | | | | | | | | | 1.994 | 0.007 |
| Total Regulation | | | | | | | | | 0.665 | 0.218 |
| Total Gates | | | | | | | | | 0.287 | 0.594 |
| Constant | -4.350 | 0.340 | -8.239 | 0.162 | -9.654 | 0.134 | -7.750 | 0.273 | -16.924 | 0.053 |
| Classification Percentage Correct / R^2 | 85.300 | 0.287 | 85.700 | 0.378 | 87.100 | 0.490 | 90.300 | 0.586 | 92.500 | 0.664 |