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Searching Hidden Links: Inferring Undisclosed Subcontractors From Public Contract Records and Employment Data

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Abstract

Many prime contractors use subcontractors to meet the DoD requirements for Small Business Utilization, to incorporate specialized skills and to perform tasks that are not the prime contractors' core business. Some of these subcontractors are not explicitly made public for a variety of reasons, including security or competitive advantage. In such cases, because the involvement of these subcontractors in certain aspects of acquisition is not known, they can pose the risk of becoming a weak, stress point despite careful planning by the DoD. This paper examines whether such undisclosed contractors can be inferred through a combined analysis of both the published purchasing data (Federal Procurement Data Systems—Next Gen) and of additional pieces of information freely available on the web. In particular, this paper investigates employment data in an attempt to correlate changes in employment with negative modifications to contracts. It is possible that, when a contract is cut, the prime contractor may terminate a subcontract, resulting in layoffs of the subcontractor's employees. Employment numbers are published regularly and broken down to county and industry codes. This paper provides a preliminary analysis showing that drops

in employment occur when small contractors have relatively large reductions in DoD contracts.

Introduction

It is not uncommon for DoD contracts to involve multiple entities, and for some prime contractors to employ subcontractors to perform specific parts of the job. For a variety of reasons, including security, confidentiality, or competitive advantage, some of these subcontractors are not publicly disclosed. One large research question is whether the open society and transparent government of the USA provides the means to uncover some of these undisclosed subcontractors. A bounty of useful information is published by the local and federal government as well as private companies and individuals. While no single government source would likely allow such information to be determined, the combination of multiple data repositories might do just that, especially if the same undisclosed contractor is part of multiple contracts.

The work presented here is a preliminary exploration of whether a correlation exists between procurement data and employment information. The main contribution is examining whether reductions in contract amounts influence employment levels in certain industries and locations. While the longer term goal would be to find hidden contractors, the first step, and the topic of the paper, is to look at known contractors who suffered cuts and see if anything can be observed in (un)employment data around the time of the cut. The reasoning is that if employment data shows a reduction in most cases of contract reductions, then the chance of discovering undisclosed contractors would be high. Note that the discovery problem would likely not have an exact answer, but rather have a probabilistic one in the sense that certain locations might be found to have a high likelihood of being the home of an undisclosed contractor for a given type of industry, while others would have a negligible chance.

The preliminary data, as explored in this paper, reveals that reductions in contracts, which are large relative to the contractor's size, are correlated to a drop in employment in more than two thirds of the cases. The paper used two types of metrics, one linked to absolute employment levels for a county and industry type and the other, location quotient (2008), providing a relative measure of a county's employment in an industry sector relative to the nation. The second metric would be able to register a drop even if a particular location had an actual increase in employment, but that increase was not as large as the national trend. The location quotient showed a decline for 75% of the contract cuts studied.

The paper covers related work in the next section, followed by an explanation of the methodology used to obtain and process the data. Results, conclusions, and future work are the topics of the last two sections.

Related Work

One approach that used public acquisition databases combined with publicly available data is based on the Company ORganization and Firm name Unifier (CORFU) technique (Álvarez-Rodríguez et al., 2013). This is a stepwise (step-by-step) method that was used to reconcile corporate names in public contracts metadata. The research study used GeoNames REST Services for contextual information, and for filtering, the study used Google Refine to validate and reconcile the data. The corporate data was from multiple sources including databases from Forbes, Google Places, Google Maps, Foursquare, LinkedIn Companies, and Facebook. "This technique is applied to the 'PublicSpending.net' initiative to show how the unification of corporate names is the cornerstone to provide a visualization service that can serve policy-makers to detect and prevent upcoming

necessities" (Llorens, Álvarez-Rodríguez, & Vafopoulos, 2015). In the study, there were over 40 million names that were extracted from public procurement datasets from Australia, the United States, the United Kingdom, and the CrocTail Project.

Another approach involved using nonprofits or commercial entities to create tools for finding and leveraging public data. Among the services that are provided were cross indexing with other data sources as well as data visualization tools. This project combined government data with information services from outside sources to provide context to the data. This technique is referred to as "mashups with other data sources" (Felten et al., 2009).

Search engines like Google are handicapped because they do not have access to agencies' internal databases. Search engines have progressed, in spite of this limitation, and perform "a significantly better job at identify relevant information." Even with this barrier, "private actors have repeatedly demonstrated that they are willing and able to build useful new tools and services on top of government data" (Felten et al., 2009) that provide better insight into the data.

Methodology

The data used in our analysis originated from Federal Procurement Data Systems—Next Gen (FPDS) and from the Bureau of Labor Statistics (BLS). The first source provides lists of federal contracts awarded during specified years, while the second publishes employment data. The data used in the research covered the period of 2013 through 2017.

Federal Procurement Data Systems (FPDS)

Our initial focus was to obtain information from FPDS on contracts for the Department of the Navy. The intention was to identify contracts with a funding reduction larger than at least a yearly salary of a qualified, skilled employee that was affecting small and medium-sized entities. From over 1.1 million entries pulled for the Navy, about 3,300 modifications to a contract were found that met the following criteria: i) the contract was reduced by more than $100,000, and ii) the vendor had between 10 and 200 employees. Both contract modification value and number of employees for the vendor are fields in FPDS.

The correlation between FPDS and BLS data is in the process of being automated, thus for this work the analysis was performed manually. This limited our ability to process all contract modifications identified in the Navy data to a more manageable 33 instances of reductions in the amount of the contract, which amount to 1% of the Navy contract reductions for the studied period.

The selection focused on instances which had been the largest drop in contract amount per unit of annual revenue. We also restricted the industry to manufacturing (NAICS code beginning with 3) and IT services (NAICS code beginning with 581). Finally, to avoid some noise in the FPDS data, the selection only included entities whose revenue was larger than $100,000 (both NAICS code of the product and annual revenue of vendor are fields in FPDS).

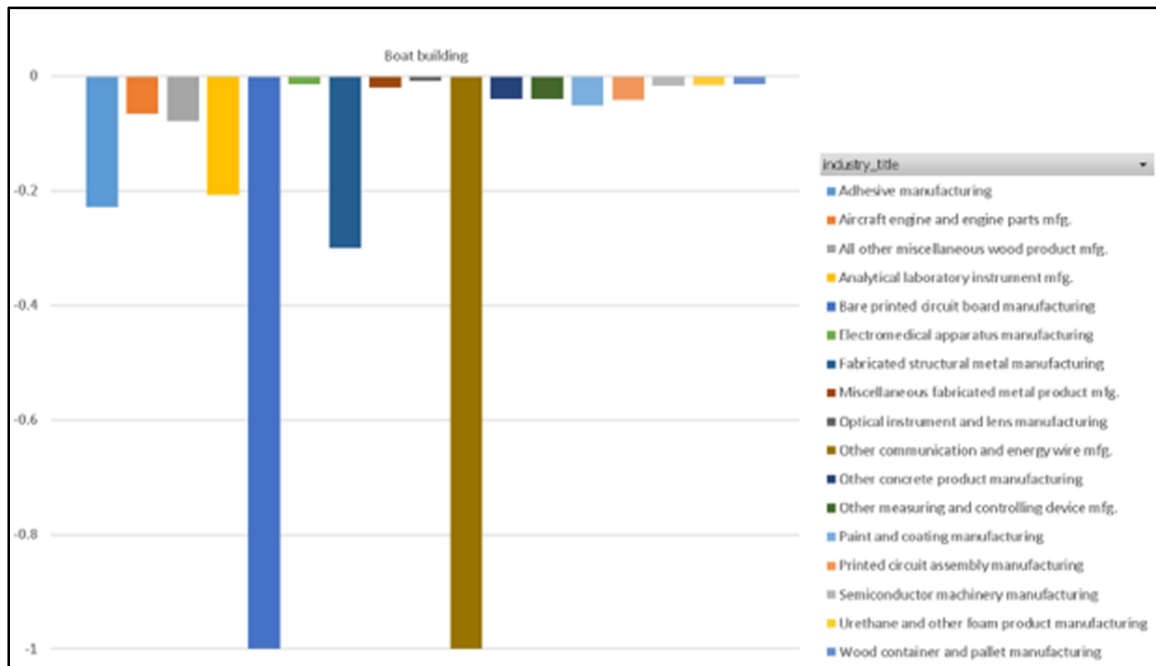### Bureau of Labor Statistics (BLS) Employment Data

The employment data provided monthly absolute employment levels and monthly location quotients for each county and type of industry. The industry codes were also using NAICS (2017) to identify the type of employers. BLS uses the NAICS code slightly differently than FPDS in that BLS identifies the type of employer, while FPDS codes the type of product provided by an employer. It is possible that one employer may have products in different, yet related industry types.

Given that the single NAICS code existing in FPDS can be too rigid, a bundle of related industries were considered for any given location and date, as sampled in Figures 1 and 2. This approach is further supported by a secondary analysis we performed, which revealed that in about one third of counties (912 counties), a drop in employment in one industry was accompanied by a drop in related industries.
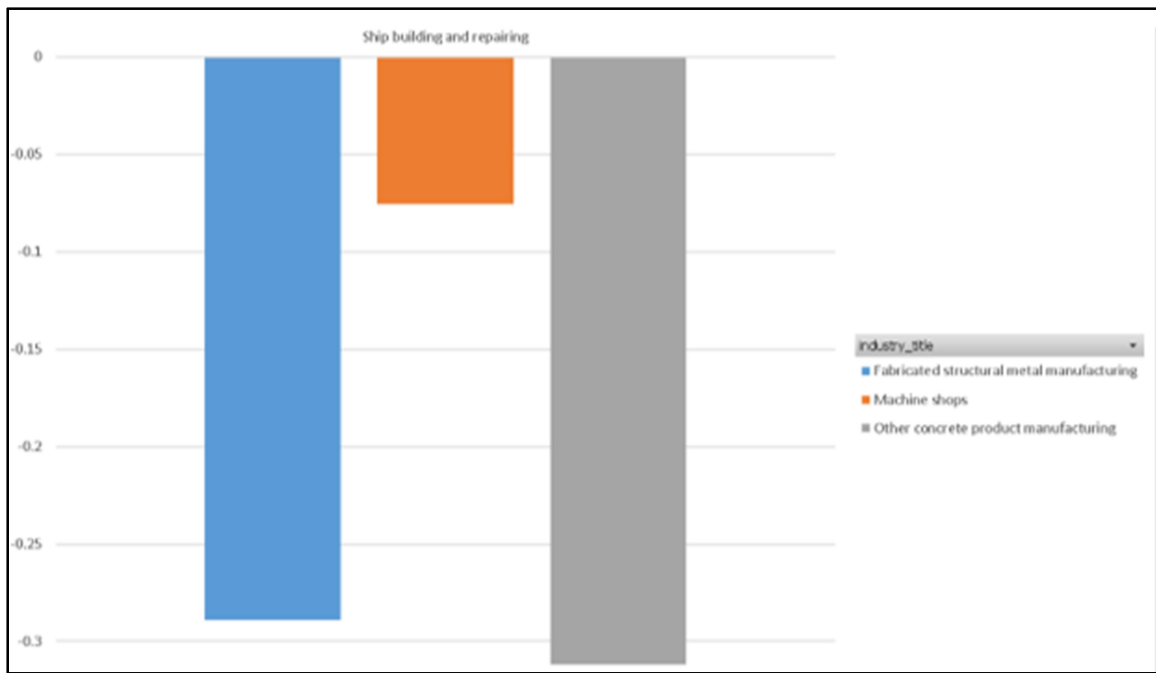
Note. The bars show relative change in employment from the quarter before to the next quarter.

Figure 1.   Sample Industry-Type Bundle for Honolulu, HI, Third Quarter 2013

Boat building

Industry_title
■ Adhesive manufacturing
■ Aircraft engine and engine parts mfg.
■ All other miscellaneous wood product mfg.
■ Analytical laboratory instrument mfg.
■ Bare printed circuit board manufacturing
■ Electromedical apparatus manufacturing
■ Fabricated structural metal manufacturing
■ Miscellaneous fabricated metal product mfg.
■ Optical instrument and lens manufacturing
■ Other communication and energy wire mfg.
■ Other concrete product manufacturing
■ Other measuring and controlling device mfg.
■ Paint and coating manufacturing
■ Printed circuit assembly manufacturing
■ Semiconductor machinery manufacturing
■ Urethane and other foam product manufacturing
■ Wood container and pallet manufacturing

Note. The bars show relative change in employment from the quarter before to the next quarter.

Figure 2.   Sample Industry Bundle for Essex, MA, Fourth Quarter 2014

Two metrics were used to estimate any potential changes in the employment situation: absolute employment level and location quotient (Bureau of Economic Analysis, 2008). The latter, location quotient (LQ), measures the local economy, county in our data, in relation to the rest of the nation. As such, it can capture cases where the absolute employment moves up or down in response to national trends unrelated to any local factors (local factors such as a cut in a Navy contract). A drop in LQ value is likely explained by a worsening of the local economy unrelated to national trends. Note that LQ can decrease even when employment increases, signifying that the increase is not taking place as quickly as in the rest of the USA.

Results

The 33 contracts studied in this paper are listed in Table 1 together with the two labor metrics of interest. This analysis took into account three months preceding and three months following the contract change to determine its impact. Averages were computed for both of the three month periods. The difference between those two averages, in percentage, is used for the rest of the analysis, both for absolute employment levels and location quotient.

Table 1.   List of 33 Instances of Contract Modifications

Name of Vendor / Cut Date	Percent change in employment level (the three months before the cut compared the three months after)	Percent change in employment location quotient (the three months before the cut compared the three months after)
AMC DEFENSE TECHNOLOGIES	**-2.25%**	**-2.89%**
9/10/2014	-2.69%	-3.47%
12/10/2014	-1.82%	-2.31%
ARNOLD DEFENSE AND ELECTRONICS	**-18.09%**	**-17.38%**
8/19/2015	-24.23%	-24.25%
7/15/2016	-12.63%	-11.27%
BARBER-NICHOLS INC.	**-15.52%**	**-15.16%**
9/28/2016	-15.52%	-15.16%
B-K MANUFACTURING CO.	**1.29%**	**1.72%**
6/3/2014	1.29%	1.72%
BOSTON SHIP REPAIR	**-53.26%**	**-51.10%**
12/5/2016	-53.26%	-51.10%
CD BIOSCIENCES INC	**57.38%**	**4.10%**
10/3/2014	57.38%	4.10%
CHAE&NAM UNIVERSE INC	**-5.67%**	**-5.75%**
8/23/2016	-5.67%	-5.75%
CORONET MACHINERY CORP.	**-12.10%**	**-12.68%**
9/25/2014	-12.10%	-12.68%
DUCWORKS	**10.05%**	**7.95%**
7/6/2016	10.05%	7.95%
EAG-LED	**-8.24%**	**-10.24%**
11/22/2016	-8.24%	-10.24%
FORM FIT AND FUNCTION	**-5.98%**	**-6.59%**
7/3/2013	-5.98%	-6.59%
G I INDUSTRIAL-MARINE	**414.68%**	**1173.90%**
9/16/2016	414.68%	1173.90%
G SYSTEMS LP	**1.03%**	**-8.07%**
9/23/2014	1.03%	-8.07%
H L TECHNOLOGIES	**2.08%**	**0.48%**
3/8/2013	2.08%	0.48%
LOGAN ENERGY CORP.	**-2.98%**	**-4.69%**
4/15/2015	-2.98%	-4.69%
MANTEC SERVICES INC.	**0.64%**	**-3.28%**
5/20/2013	0.64%	-3.28%
MOBILE TECHNICAL	**-46.62%**	**-47.53%**

SYSTEMS		
3/8/2016	-46.62%	-47.53%
OWL INTERNATIONAL INC.	**-8.38%**	**-12.04%**
8/8/2013	-8.38%	-12.04%
PACIFIC ENGINEERING INC.	**-16.25%**	**-18.94%**
4/21/2015	-16.25%	-18.94%
PELATRON	**-8.53%**	**-10.75%**
9/4/2013	-8.38%	-12.04%
5/6/2014	-8.67%	-9.57%
RIBCRAFT USA	**-11.98%**	**-11.88%**
11/5/2014	-11.43%	-10.61%
3/2/2017	-12.69%	-13.52%
SEA-LECT PLASTIC CORPORATION	**129.60%**	**35.31%**
11/20/2013	141.25%	37.46%
1/15/2015	98.89%	24.04%
1/14/2016	151.49%	45.60%
SUMMIT SOLUTIONS OF COLORADO	**-6.68%**	**-6.88%**
11/20/2014	-9.98%	-7.99%
3/26/2015	-3.39%	-5.77%
SWIFTSHIPS	**-51.04%**	**-47.73%**
8/30/2016	-51.04%	-47.73%
SYSTEMS APPLICATIONS&SOLUTIO	**3.39%**	**-1.04%**
5/12/2014	3.39%	-1.04%
WHITAKER TECHNOLOGIES	**-5.67%**	**-8.84%**
6/10/2014	-5.67%	-8.84%

Note. Aggregated data for each vendor as well as individual reductions by date are provided.

In a clear majority of the cases included in the study, a reduction in a contract is correlated with a drop in employment indicators, when comparing the average employment numbers the quarter (three months) before the reduction date with the quarter after. The absolute employment level was reduced in 22 out of 33 instances, or 66.6% of time. Similarly, the location quotient displays a drop in 25 out of 33 cases (75.7%). Figure 3 shows an overview of the two metrics. The data has a few outliers, especially on the positive side of the change, where the location quotient increased significantly in one instance.
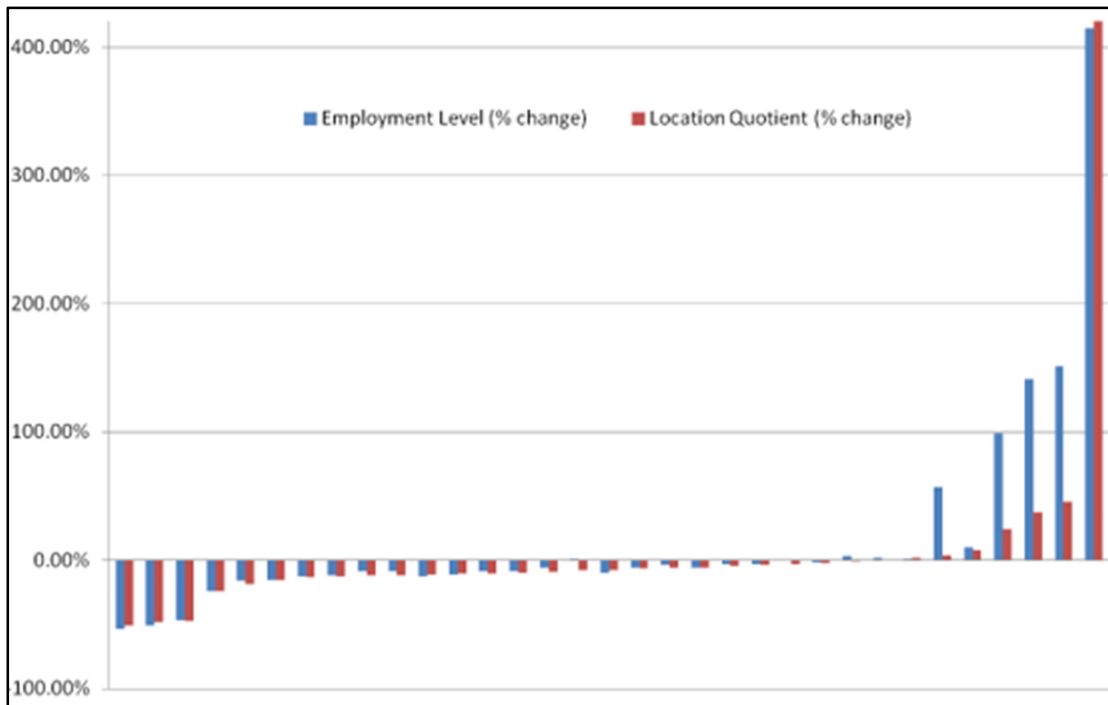
Note. The x-axis lists all 33 cases of contract reduction and is ordered by location quotient. The right-most red bar is not shown in its entirety as it would reach up to almost 1,200%.

Figure 3.   Percentage Change in Employment Level (Blue) and Location Quotient (Red) Before and After a Reduction in a Federal Contract

The study also examined the correlation between the magnitude of the reduction and the magnitude of the change in employment indicators, but in the limited cases (33) that were available, the correlation was relatively weak. Even when removing positive outliers (the right side of Figure 3), R^2 was about 0.3 for both employment level and quotient. For the revenue of a vendor to change in employment, the correlation was only marginally better ($R^2 \approx 0.4$).

Conclusion and Future Work

The paper presented a preliminary study that shows that large reductions in federal contracts are correlated in a majority of cases (66% or 75%, depending on the metric used) to drops in employment in a given region and industry. This finding shows that it is possible to determine the location of an undisclosed contractor by examining public employment data at the times when large contracts are reduced or simply reach the end of their period. Such undisclosed contractors are typically employed by larger government contractors to achieve confidentiality, security, or a competitive advantage. Depending on the situation, acquisition experts may need additional planning to protect such hidden contractors if security is desired, or may rely on data science to identify these contractors and avoid them becoming a weak link in the acquisition process.

The main contributions of the paper, besides the study itself, are the development of a framework for joining acquisition and employment data and the testing of the industry-type bundles for a given location and time frame. However, the main limitation of this study is the reliance on the quasi-manual joining of the acquisition (FPDS) and employment (BLS) data. As such, future work will focus on extending the database of DoD contracts and employment information and on automating the process of correlating industry types, locations, and

dates. This will result in thousands more entries being analyzed, and the possibility of employing powerful statistical methods to better filter external factors (noise) from the analysis. Finally, in addition to studying reductions in contracts, we can analyze the effect that awarding new contracts or increasing the amount of existing contracts has on local job metrics.

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