# Internal Labor Markets and Productivity

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**Abstract**

In this paper, we study how the design of an internal labor market impacts the daily productivity of an organization. We exploit the existence of an informal frictional internal labor market for overtime among 535 Los Angeles traffic officers. Overtime opportunities are valuable because they are paid at 1.5 times the normal wage and often involve directing traffic at high-profile events like the Oscars. Although overtime is assigned fairly initially, officers use informal networks within the organization to trade shifts, leading to inequality in who actually works overtime. We construct the network of potential past contact by measuring the number of times each pair of officers works in the same location and date. We use variation over time in how well-connected an officer is to identifying officer valuations for overtime shifts. We estimate each officer's skill at the core tasks of the job: issuing parking tickets and reducing traffic collisions. We plan to show how informal trading sorts workers with different skills into overtime, and compare this to counterfactual random assignment and a centralized shift auction.

*Keywords:* internal labor markets, labor supply, selection
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# 1 Introduction

People vary greatly in their labor supply (Blundell, Bozio, and Laroque 2011), even within organizations. Among Los Angeles traffic officers, a city report documents that in a single year, one worker earned $15 in overtime while another earned over $100,000 (Galperin 2015). People also vary in their skill across tasks. Depending on the connection between a worker's skills and their desire to work, the existence and structure of an internal labor market can help or hurt the overall productivity of an organization.

To study the connection between internal labor markets and productivity, we combine individual daily pay data with the unique institutional features of the internal labor market of Los Angeles traffic officers. Among Los Angeles traffic officers, overtime opportunities are coveted because they pay a premium rate (1.5 times the normal hourly wage) and frequently involve high-profile events like the Oscars and Golden Globes. Because they are coveted, overtime opportunities are assigned fairly ex-ante via a constantly turning "wheel" which is a computer program that assigns overtime shifts sequentially as they come along to a revolving list of officers.

Despite fair ex-ante assignment by the wheel, the data reveal significant ex-post inequality in overtime worked. A government report reveals that this is because of internal trading of shifts via informal networks, where the most connected officers who acquire the most overtime are colloquially referred to as "the cartel." We track the potential network of officers by measuring the amount of time they work in the same division (office) on the same day as other officers. We show that, just as the government report suggests, an officer's past network centrality predicts future overtime.

Specifically, we measure the number of times each pair of officers works in the same division (location) on the same date in a three month window prior to a given date. Importantly we down-weight time spent in crowded locations and up-weight time spent in sparse locations. We construct the network of potential contact for every date in the sample, and we measure how well-connected an officer is by totaling their potential contact across all other officers. We show that potential contact varies both across officers in the cross-section and across time within officer due to retirements, location changes, new hires and scheduling differences.

We identify an officer's value for an overtime shift by exploiting variation in each officer's network centrality over time. Intuitively, an officer who works an overtime shift when they are not well-connected likely values the shift more because they had to search more for a trading partner. Variation in centrality over time comes from own and coworker work location changes, new hires and retirements of other officers, and changes in own and coworker

work schedules. Our instrument is highly predictive of overtime work even conditional on individual fixed effects.

We are in the process of measuring each officer's time invariant skill at two tasks: preventing traffic collisions and issuing parking citations. We use daily data which documents the locations, times and dates of collisions and parking citations in Los Angeles. Using the approach suggested by Bonhomme 2021, we use variation in the composition of officers across the city over time to identify each officer's skill along the two dimensions. We then study how the existing internal labor market, which uses informal networks, sorts workers into overtime and impacts the LADOT's overall productivity. We compare this sytem to random assignment with full compliance.

We plan to simulate two counterfactuals. In the first, informal trading is replaced by centralized assignment by a manager based on observables. In the second, informal trading is replaced by a formal shift auction where officer's bid a wage. We plan to study how these changes shape sorting along the two dimensions of productivity. The counterfactuals illustrate a broader message: internal labor markets can be designed to achieve organizational objectives with the same workforce, in this case reducing collisions and increasing parking citations.

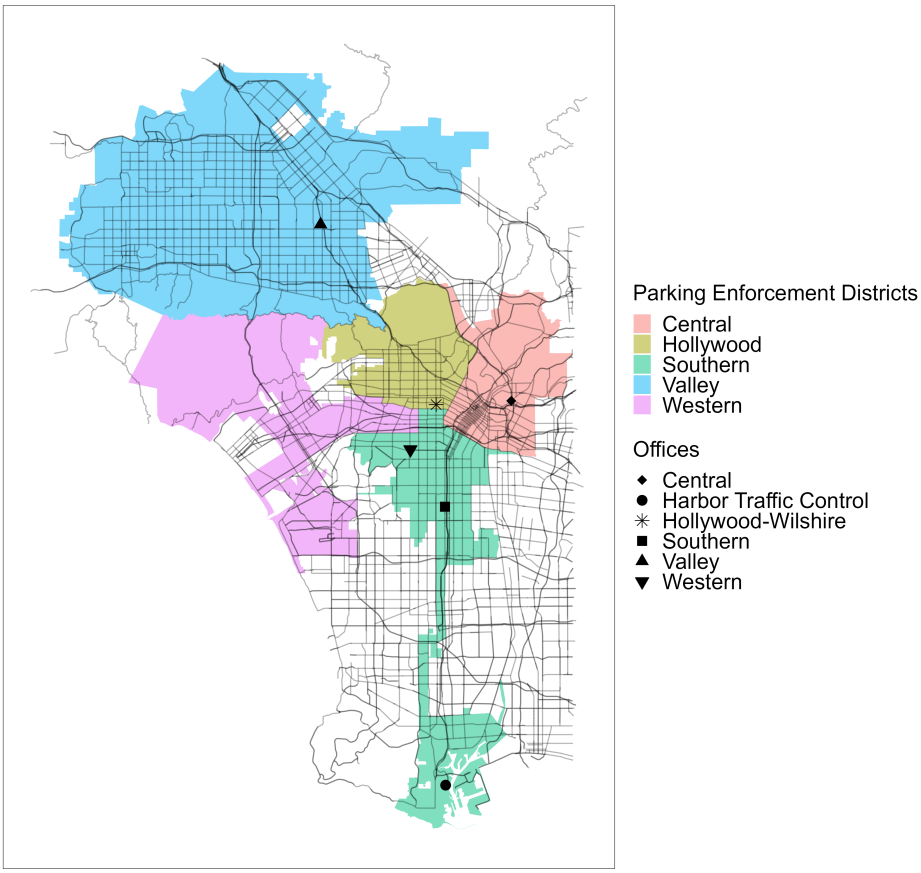
Los Angeles traffic officers are an in ideal setting for studying internal labor markets. They are highly substitutable and have well-defined tasks. They share the same occupation and job title and progress along a common wage scale because they are unionized. The existence of a long-standing internal labor market, where officers not only trade but also sell shifts for cash, allows us to recover how officers value overtime and relate this to measures of productivity.

# 2 Institutional Details

The population and setting studied in this analysis are traffic officers working in the Los Angeles Department of Transportation (LADOT). The city of Los Angeles is divided into six geographic parking enforcement districts. Each parking enforcement district has an office. Offices are districts are depicted in Figure 1. Traffic officers operate over a large geographic area: many parts of the Valley District are more than 40 miles from Harbor Traffic Control.

Traffic officers are allocated to divisions which are usually associated with the geographic districts. Regular work assignments are controlled at the division level, and special event work assignments, which we will describe shortly, are disseminated by division. Video footage posted by the LADOT shows that traffic officers do a roll call at their assigned office. For these reasons, we will refer to officers who work in the same division as "coworkers."

**Figure 1:** Parking Enforcement Districts and Offices




Traffic officers have two core duties: parking enforcement and traffic control.[1] Parking enforcement duties primarily consist of patrolling a designated beat to identify and cite vehicles and drivers in violation of Los Angeles and California codes, while traffic control duties consist of directing traffic at assigned locations to prevent gridlock, placing traffic control devices (e.g., barricades or flares), and managing roadways when traffic accidents occur. While some traffic work is routine (e.g., daily management of an intersection known to suffer from congestion), the vast majority is caused by permitted *special events*. Examples of special events include the Los Angeles Marathon, Dodger games, the Oscars, parades, protests, and block parties. Los Angeles hosts several thousand permitted special events every year. Whenever a special event would impact traffic and parking in the city, traffic officers are assigned to help manage those impacts. Thus while these special events can

[1]A description of the traffic officer role can be found on the city website here https://personnel.lacity.gov/perspecs/3214.pdf as can a list of core traffic officer tasks herehttps://personnel.lacity.gov/doc.cfm?get=Task3214.

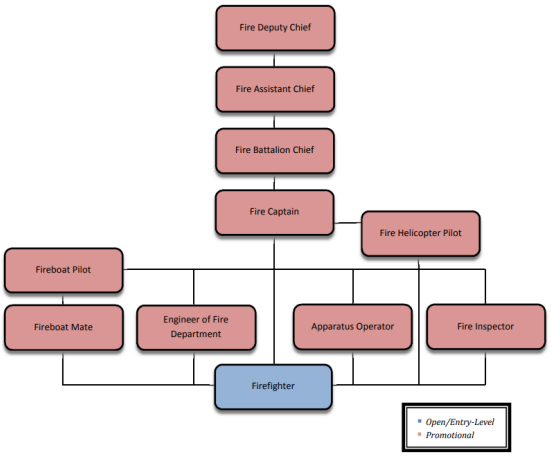
create additional labor demand for traffic officers, these events involve many of the same tasks as routine traffic control.

Around 80% of regularly scheduled traffic officer time is spent on parking enforcement, and a majority of traffic officers are allocated exclusively to parking enforcement duties for their scheduled working hours. Since the mid-2000s, the routine traffic control duties that comprise the other 20% of regularly scheduled time have also been performed by officers allocated exclusively to traffic control. Officers generally work alone when performing regularly scheduled parking enforcement and traffic control duties. Large special events are the primary scenario in which multiple officers would be working in proximity to each other.

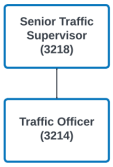
We highlight that traffic officers are highly substitutable between shifts and work assignments. While the assigned beat and parking conditions can vary, the core task of parking enforcement is fundamentally identical between officers. While each special event is unique, the direction of traffic always consists of the same set of tasks, which is small in breadth. May of the hand signals and routines used to manage traffic are actually documented by the LADOT in public YouTube training videos. These tasks do not appear to create much opportunity for complementarities between officers or teamwork; a special event as large as the Oscars will require a large group of traffic officers, but there is not much scaling in the complexity of the work. Different traffic officers will have varying levels of productivity and skill—that some officers can perform their jobs with a lower chance of injury, for instance, is central to our argument— but there is limited opportunity or need for specialization. This is highlighted in Figure 2, which shows career ladders for traffic officers and firefighters created by the Los Angeles personnel department. Firefighters in Los Angeles have viable career progressions involving the development of specialized skill sets. Consider fire inspections. Firefighters are responsible for conducting inspections of basic buildings and structures, whereas the fire inspector position listed in Panel A involves conducting complex fire inspections such as those of skyscrapers and stadiums. While both roles involve the core task of "fire inspection," the city has established different classifications to indicate which employees in the fire department can conduct which inspections. In contrast, Panel B shows the career progression and lateral moves available to traffic officers. Notably, the only possible promotion is into a supervisory position over a team traffic officers. For the breadth of work needed to enforce the parking code in Los Angeles, one non-supervisory job classification is sufficient.

Traffic officers are union employees covered by the Memorandum of Understanding 18 (MOU) between the City of Los Angeles and Service Employees International Union Local

**Figure 2:** Career Progressions for Firefighters and Traffic Officers




**(a)** Firefighter




**(b)** Traffic Officer

**Note.** Los Angeles provides a career ladder describing potential promotions and lateral movements for each employee classification (available here: https://personnel.lacity.gov/jobs/career-ladders.cfm). Panel A shows the ladder for firefighters, while Panel B shows the equivalent ladder for traffic officers.

721.[2]. According to the MOU, traffic officers are assigned fixed and regular workweeks and work schedules (e.g., a 5/8 or a 4/10 work schedule). The regular salary for traffic officers is standardized by the MOU. During the period of our analysis, the MOU establishes the overall salary range as roughly $47,000 to $64,000. Exact salary is determined by tenure using a step structure. After completing the probationary period, a traffic officer will generally qualify for a step increase every twelve months, translating into a roughly 3% raise.

According to the MOU, traffic officers are non-exempt employees eligible for overtime pay under the Fair Labor Standards Act (Department of Labor 2017), and so the MOU also derives an hourly rate using the salary for each step. Any hours worked in excess of 40 during a workweek is considered overtime pay. The MOU dictates that all overtime and "early report" hours[3] will be compensated at a rate of 1.5 times an employees usual hourly rate.

A consequence of the high degree of substitutability is that most traffic officers are eligible to complete overtime work, should the need arise. Based on a conversation we had with a traffic supervisor, the only officers excluded from special events overtime are those in their probationary period[4]. Non-probationary Los Angeles traffic officers control their labor supply

[2]The version reviewed is available online: cao.lacity.org/MOUs/MOU18-18.pdf

[3]The city is required to pay a minimum of four hours of premium pay if an employee is required to return to work "following the termination of their shift and their departure from the work location" (MOU, 30).

[4]Probationary officers appear in our data and in city documentation with the job title "Traffic Officer I,"

by working overtime shifts. Over 150,867 hours were billed to overtime pay codes in calendar year 2015. This overtime comes from two sources. First, there is routine overtime arising from excess demand for traffic control due to something like an emergency or a construction project (e.g., a burst pipe or a broken traffic light). Second, pursuant to the MOU, all special events work is paid out as overtime. Based on city reports, in fiscal year 2013-2014 (the year prior to our data), 80% of all overtime paid out to employees within the Department of Transportation Parking Enforcement and Traffic Control was due to special events.

The MOU prescribes a general policy for the assignment of overtime amongst traffic officers: "Management will attempt to assign overtime work as equitably as possible among all qualified employees in the same classification, in the same organizational unit and work location" (MOU, 27). For this reason our paper focuses on the decision to work additional shifts rather than the decision to work additional hours.

How exactly overtime is assigned to individual officers is not spelled out in the MOU. However, a report by the City Controller's office (Galperin 2015) gives more details about special events overtime. Any event with sufficient advance notice is coordinated centrally by DOT and overtime is assigned using a mechanism officers call "spinning the wheel." Under the wheel spin system, officers first volunteer to be on an overtime list. The list is ordered by seniority. At the start of each month, the DOT "spins the wheel" by offering special event overtime sequentially to officers in the order they appear on the list. The wheel continues to spin until all special events overseen by the central Special Events Office are staffed. For those events with less than six days advance notice, an analogous version of the wheel is spun at the district level, using a list containing only the officers assigned to that district.

The LADOT continues to spin the wheel month after month, as do the district offices with their wheel. Because the wheel spins continually, and given that thousands of special events occur each year in Los Angeles, the initial assignment of any particular officer to any particular special event is as good as random, and the cumulative amount of overtime assigned over any period longer than a few weeks will be similar across any officers who have volunteered. In practice though, the observed amount of overtime between officers varies wildly, a fact we document in Figure 3.

This imbalance is largely the result of shift trading between officers. Once the wheel has been spun, special event assignments are sent to area supervisors and are posted on bulletin boards in staff areas. After seeing their assignment, an officer assigned a shift may work it or find a substitute. Documentation of substitutions is not enforced by DOT, but the aforementioned City Controller's report recounts that such trading is pervasive with

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while non-probationary officers have the Title "Traffic Officer II." Across 43,805 person-days in our period of analysis, we find only one record of a Traffic Officer I working an overtime shift

regard to overtime shifts. While only 192 officers signed up to volunteer in FY 2013-2014[5], 471 officers worked overtime, suggesting that not only is trading pervasive, it even induces non-volunteers to work special events. During the period we consider, officers also had wide latitude to use any accumulated sick time or leave time to fulfill any scheduled non-overtime shift, including calling out of their scheduled shift in order to work an special event overtime shift instead[6]. In sum, the combination of written policies and departmental norms within LADOT created a workplace in which most officers could work most overtime shifts, provided they could find a trading partner.

Crucially, trading overtime shifts requires a bilateral trade: an officer must give up an assigned shift and another officer must take on an unassigned shift. Special event overtime guarantees a higher pay rate and also the amenity value of working certain high-profile events and so many officers might be willing to trade into an overtime shift if it is not costly to do so. Among the thousands of special events in the period, some are particularly likely to involve exposure to entertainment and celebrities. We list several notable examples in Table 1.

| Event Name | Date |
|---|---|
| 57th Annual Grammy Awards | 2/8/2015 |
| Faith Evan's Grammy After Party | 2/8/2015 |
| The 87th Academy Awards (Oscars) | 2/22/2015 |
| Katy Perry Prismatic World Tour | 3/26/2015 |
| Ice Cube, MC Ren and Yella Concert (NWA Reunion) | 6/29/2015 |
| Taylor Swift Concert (1989 World Tour) | 8/21/2015 |
| Billionaire Dennis Tito's Holiday Party | 12/11/2015 |

**Table 1:** Notable Special Events

Shift trading among traffic officers involves banking of favors to be repaid in the future, the use of social status, and even side payments in cash between officers. We remain agnostic about the exact currencies used to facilitate any particular trade, but highlight that these trades all happen within a network. In theory, any non-probationary officer is capable of trading for a shift; however, in practice officers need to be able identify trading partners and convince them to trade. In our discussions with a supervisor, trades are facilitated both via word-of-mouth and via an informal online forum. Consequently, an officer who cultivates a

[5]This is the year prior to our analysis period which spans part of FY 2014-2015 and FY 2015-2016.

[6]This possibility was in fact intended by the DOT and union to create more equitable access to overtime: unless officers were allowed to call out of a normal shift and work a contemporaneous special event, officers with work schedules that substantially overlap special events would rarely be able to work overtime

more extensive or dense network should have an advantage among their peers with regard to the flexibility and availability of overtime shifts. In city reports, Parking Enforcement and Traffic Control staff have raised concerns about officers who make use of their networks in exactly this way. Referring to these officers as "The Cartel," Galperin 2015 highlights that officers cultivate relationships in order to obtain high-value special event overtime shifts, and this report recommends that the city implement reforms to increase the fairness with which overtime is actually worked.

# 3 Data

The data consist of worker's compensation claims and payroll records for all Los Angeles traffic officers. The payroll data record daily work activity, including amount and type of wages paid and hours worked. The data comes from a discontinued city project, and it was subsequently released as public record.[7]

We compile a daily panel data set tracing overtime and standard work between January 1, 2015 through June 30, 2016. Summary statistics are provided in Table 2. Officers vary significantly in their tenure, age and work patterns.

**Table 2:** Summary Statistics

| Statistic | N | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|---|
| Wage | 274,908 | 29.988 | 2.356 | 19.804 | 33.992 |
| Age | 274,908 | 46.792 | 8.984 | 23.195 | 68.475 |
| Tenure | 274,908 | 15.039 | 8.140 | 1.569 | 44.413 |
| Standard Work | 274,908 | 0.673 | 0.469 | 0 | 1 |
| Overtime | 274,908 | 0.139 | 0.346 | 0 | 1 |
| Injury | 274,908 | 0.001 | 0.029 | 0 | 1 |
| Medical Expenses | 233 | 2,606.963 | 3,879.846 | 0.000 | 33,563.260 |

# 4 Stylized Facts

Our first fact confirms what the government report found in 2013-2014. Despite the fact that overtime is assigned ex-ante fairly by the wheel, there is a large amount of inequality in the terms of which officers actually work overtime.

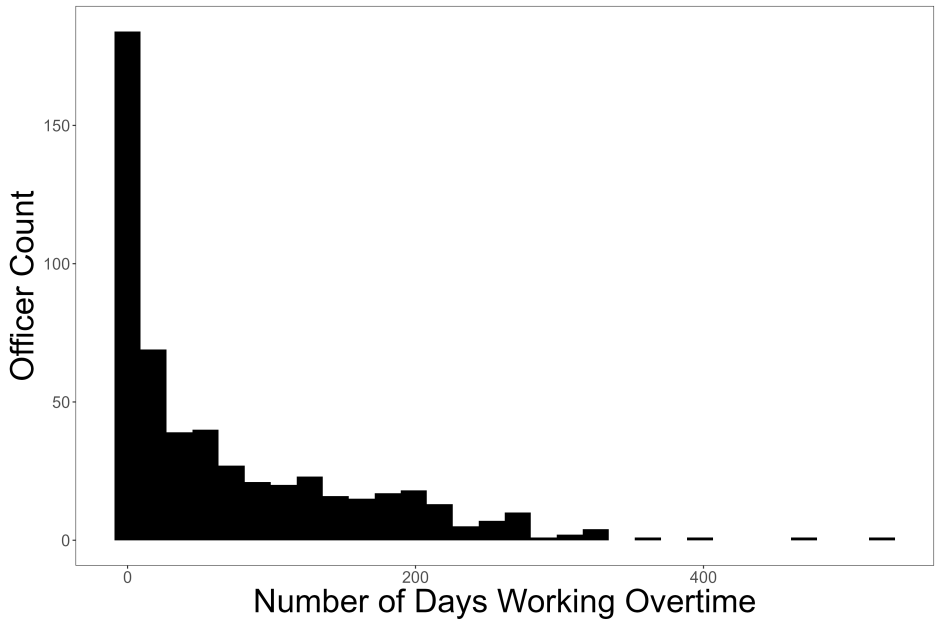
[7]We provide the raw data in full at https://drive.google.com/file/d/1sagxWTnkwyi1J8Z6sXOPUPZ1JjMzACKR/view?usp=sharing.

**Fact 1.** Overtime shifts are unevenly distributed across officers.

We present Fact 1 visually in Figure 3, which plots a histogram of officers by the number of distinct dates they are observed working overtime. We confirm the finding in the government report, that overtime worked is distributed extremely unevenly, with a small number of officers working a large amount of overtime. In the far right tail we also confirm the existence of some officers who might be part of the "cartel" documented in the government report. These officers are observed working overtime on 400 distinct dates in a 546-day period.

We provide several statistics to quantify the dispersion in overtime. An officer at the 25th percentile works 4 overtime shifts, while an officer at the 75th percentile works 121 shifts, which is 30.3 times more. If we limit only to officers observed working at least one overtime shift, dispersion is still large. An officer in this subsample at the 25th percentile works 12 overtime shifts, while an officer at the 75th percentile works 134 shifts, which is 11.2 times more. In order to account for people who are entering or leaving the organization, we also compute these statistics in terms of percentages of shifts employed and we verify that the ratio of the 75th to the 25th percentile is similar.

**Figure 3:** Distribution of Overtime Across Officers




There are a fixed number of special event overtime shifts that are distributed based on "wheels," one organization-wide and one for each division. An officer's initial position on the wheel is determined by seniority, but because the wheel is not reset and is always turning, direct overtime assignments are fair over time. Yet, ex-post overtime worked is quite unequal, and the government report provides an explanation: "Traffic Officers may be

able to receive more overtime if they have nurtured relationships and know how to network, treating overtime assignments as a privilege that can be traded."

To assess this claim, we measure the potential contact between pairs of officers in the following way. We define a variable $p_t(i, i')$. For officer pair $(i, i')$ on date $t$, we check whether both officers worked at the same division. If they did not, we set $p_t(i, i') = 0$. If they did overlap, we compute the total number of officers who worked at that division, call it $N_{i,t}$ and set $p_t(i, i') = \frac{1}{N_{i,t}-1}$. We measure the total potential contact between officer pair $(i, i')$ prior to date $t$ in the past $M = 90$ days as: $\sum_{\tau=t-1}^{t-M} p_\tau(i, i')$. We compute this measure for all pairs of officers and for all dates.[8]

The set of active officers on any date $t$ are those hired weakly before $t$ and those terminated weakly after $t$. For any fixed $t$, we can then use the set of active officers and their pairwise measures $z_t(i, i')$ to construct a weighted undirected network $G_t$, which we call the network of potential contact. Two officers that never worked in the same division on the same day in the last 90 days are unconnected because $z_t(i, i') = 0$. Among those with a connection, the strength of that connection is proportional to the number of times they worked alongside each other weighted by the number of other officers present.

The measure is meant to capture the fact that officers likely report to their division office to pick up their vehicles and gather information, but leave the office to perform their duties. Further evidence for this view comes from promotional videos posted by the LADOT. These videos show officers gathered within the West Hollywood office, engaging in what appears to be a daily roll call meeting. The measure also captures crowd out: officers who overlap on a day in a division with many other officers have less one-on-one contact.

We illustrate what drives variation in the measure of potential content with several examples. Parking rules are relaxed on Sundays in Los Angeles, and the data reflect that fewer traffic officers work on Sundays. If two officers do happen to work on Sunday, we will assign them a high value of $z_t(i, i')$ because there are fewer other officers to crowd out their interaction.

We summarize an officer's connectedness in the organization by constructing each officer's potential contact centrality. This is the sum of their potential contact with all other officers in the organization: $z_{i,t} = \sum_{i'} z_t(i, i')$. A 1 unit increase in the measure is equivalent to one additional opportunity for a pairwise interaction with another officer. A half unit increase is equivalent to one additional opportunity to interact with another officer when a "third wheel" officer is present.

Potential contact centrality measures how well-connected the officer is, incorporating

[8] We also compute the measure for different rolling window lengths $M$.

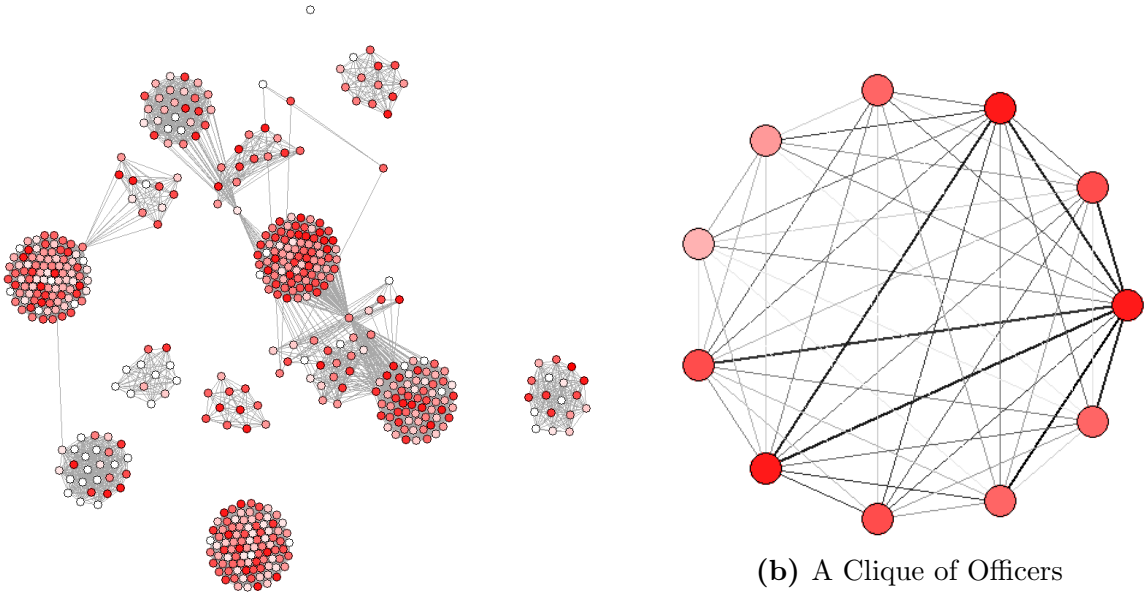
both the breadth and depth of connections. Consider a potential contact centrality of 60, a common value in the data. An officer could have this value if they overlapped with the same other officer in the same location for 60 of the last 90 days, and had no potential contact with anyone else. An officer could also have this value because they overlapped with two other officers in different locations for 30 days each. When considering changes in potential contact centrality, it is helpful to measure them in pairwise equivalents.

**Fact 2.** Potential contact centrality varies both across officers and across time within officer.

Among all officer-days, the 25th percentile of potential contact centrality is 59.7 while the 75 percentile is 65.8. Such a difference can be interpreted as 6 additional potential pairwise interactions. We illustrate the variation in the cross section by depicting the network of potential contact on the first day of the analysis period in Figure 4. Each node is an officer, and each officer is colored based on the quantile of their potential contact centrality on January 1, 2015. In Panel A we show the full network, where officers with any potential contact in the last three months are considered connected. Large clusters reflect officers working in the same geographic division. Officers that switch divisions form bridges across clusters.

In Panel B we zoom in on a small disconnected part of the network to show that connection strength varies even within groups of officers that have all worked together. Schedule differences and variation in how often officers worked in the past drive differences in the strength of pairwise connections. All the officers in Panel B have worked together, but a small handful have worked together very often, which is why their centrality is high.

**Figure 4:** The Network of Potential Contact on January 1, 2015

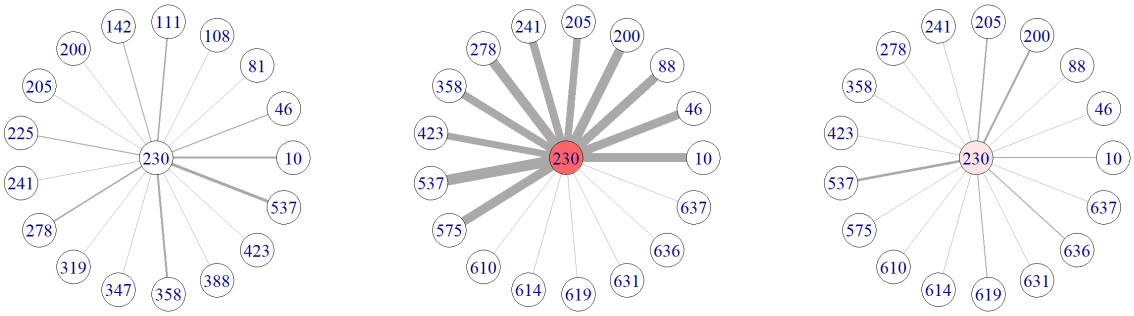


**(a)** All Officers

**(b)** A Clique of Officers

**Note.** Panel A features all employed traffic officer IIs on January 1, 2015. Two officers are plotted as connected long as there is some potential contact in the last 3 months. Panel B focuses on a set of officers that are all connected to each other but disconnected from all others. Connections are plotted with a thickness which is based on the amount of potential contact. Officer node color is based on the potential contact centrality of that officer, with red denoting high centrality.

**Figure 5:** Variation in Potential Contact Centrality Across Time



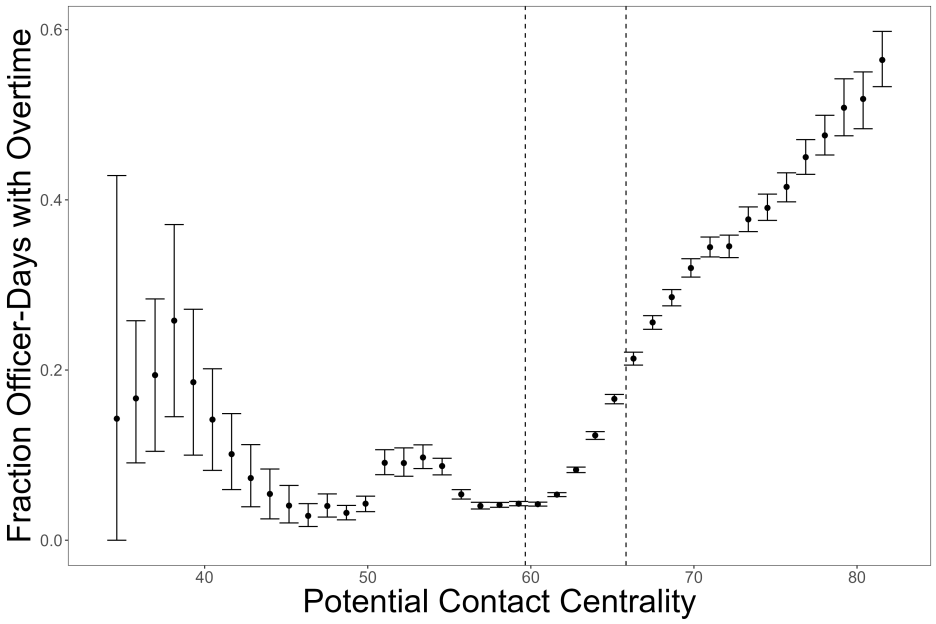

**(a)** January 1, 2015 **(b)** July 1, 2015 **(c)** January 1, 2016

**Note.** The panels show the connections of Officer 230 at three different points in time, with the color of Officer 230's node related to their potential contact centrality on each date.

**Fact 3.** On dates where officers are well connected, they are more likely to work overtime.

We capture this fact visually in Figure 6, where we compute the fraction of officer-days with overtime within 40 equally spaced bins based on potential contact centrality. We exclude the top 1% and bottom 1% of officer-days for visual clarity, and we indicate with dashed lines the 25th and 75th percentile of potential contact centrality. As centrality rises, average overtime probability also rises from around 10% to over 50%. The figure incorporates both cross-sectional variation in centrality and within-officer temporal variation in centrality. However, we show in Figure **??** that even if we focus on within-officer variation the increasing relationship remains. We later use this variation for identification.

**Figure 6:** Binned Scatter Plot of Centrality and Overtime




**Note.** Standard errors are computed using the nonparametric bootstrap and 1,000 replications.

Fact 3 is consistent with both the government report and conversations with a supervisor within the LADOT. The wheel determines initial allocations of overtime fairly. Afterwards, officers can bilaterally swap and sell overtime without management intervention. This is done by word of mouth as well as via informal forums setup online. Our measure of centrality captures both the breadth and depth of potential past contact with other officers, and serves as a proxy for the trading frictions faced by each officer.

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# A Appendix

# B Additional Tables