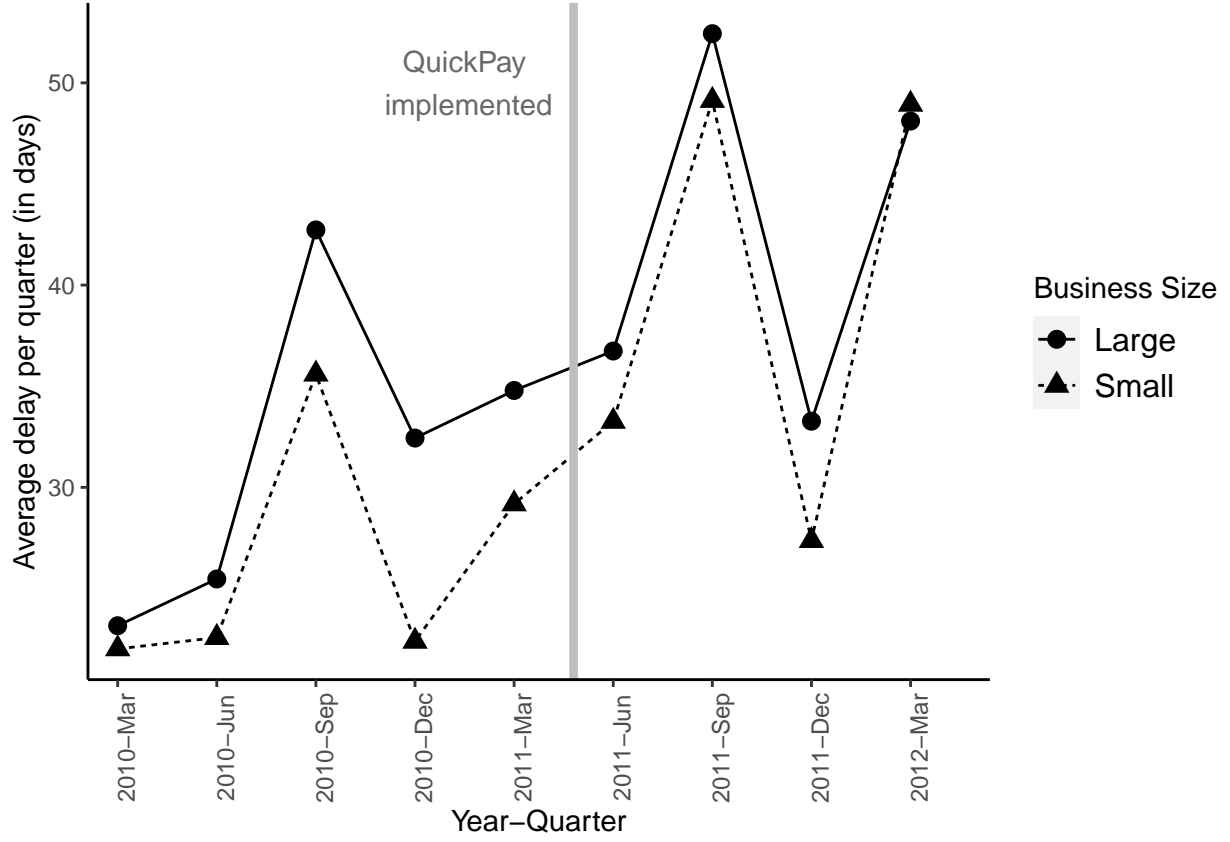


# First Implementation of QuickPay (2009-2012)

Mar 31, 2021

## 1 Delays over Time



## 2 Notation

- Project  $i$ , Year-Quarter  $t$
- $X_i$  denotes project level controls: initial duration, initial budget, number of offers received
- $\mu_t, \theta_{firm}, \lambda_{task}$ : Year-Quarter, Firm, and Product/Service code Fixed effects
- All continuous variables are winsorized at the 5% level

$$Treat_i = \begin{cases} 1, & \text{if project } i \text{ is a small business} \\ 0, & \text{otherwise} \end{cases}$$

$$Post_t = \begin{cases} 1, & \text{if year-quarter } t > \text{April 27, 2011} \\ 0, & \text{otherwise} \end{cases}$$

### 3 Parallel Trends Test

Let  $Time$  denote  $q$ -th quarter since the beginning of time horizon. For  $Post_t = 0$ , we run the following regression:

$$Delay_{it} = \alpha + \beta_0 Treat_i + \beta_1 (Treat_i \times Time) + \beta_2 X_i + \mu_t + \theta_{firm} + \lambda_{task} + \epsilon_{it}$$

The coefficient of interest is  $\beta_1$ . If this is significant, we would find evidence of a linear time trend before quickpay implementation – violating the parallel trends assumption.

Table 1: Linear Time Trend Before QuickPay

<i>Dependent variable:</i>	
<i>Delay<sub>it</sub></i> (in days)	
<i>Treat<sub>i</sub></i>	−1.10 (2.98)
<i>Treat<sub>i</sub> × Time</i>	−0.01 (0.49)
Fixed effects	Firm, Task, and Year-Quarter
Controls	Budget, Duration, Bids
Observations	74,677
R <sup>2</sup>	0.14
Adjusted R <sup>2</sup>	0.03

*Note:* \*p<0.1; \*\*p<0.05; \*\*\*p<0.01  
Each observation is a project-quarter.  
SEs are robust and clustered at the project level.  
Observations are for quarters before quickpay.

### 4 Baseline Regressions

$$Delay_{it} = \alpha + \beta_0 Treat_i + \beta_1 Post_t + \beta_2 (Treat_i \times Post_t) + \epsilon_{it}$$

$$+ \alpha + \beta_0 Treat_i + \beta_1 Post_t + \beta_2 (Treat_i \times Post_t) + X_i + (Post_t \times X_i) + \mu_t + \theta_{firm} + \lambda_{task} + \epsilon_{it}$$

Table 2: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)		
	(1)	(2)	(3)
<i>Treat<sub>i</sub></i>	-6.19*** (0.50)	-3.58** (1.55)	-3.09* (1.59)
<i>Post<sub>t</sub></i>	13.04*** (0.52)		
<i>Treat<sub>i</sub> × Post<sub>t</sub></i>	3.35*** (0.73)	6.88*** (0.91)	6.83*** (0.92)
Constant	33.00*** (0.36)		
Year-Quarter Fixed Effects	No	Yes	Yes
Firm Fixed Effects	No	Yes	Yes
Task Fixed Effects	No	No	Yes
Duration, Budget, Bids	No	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes
Observations	173,900	155,638	155,638
R <sup>2</sup>	0.01	0.11	0.12
Adjusted R <sup>2</sup>	0.01	0.05	0.05

Note:

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

Each observation is a project-quarter.

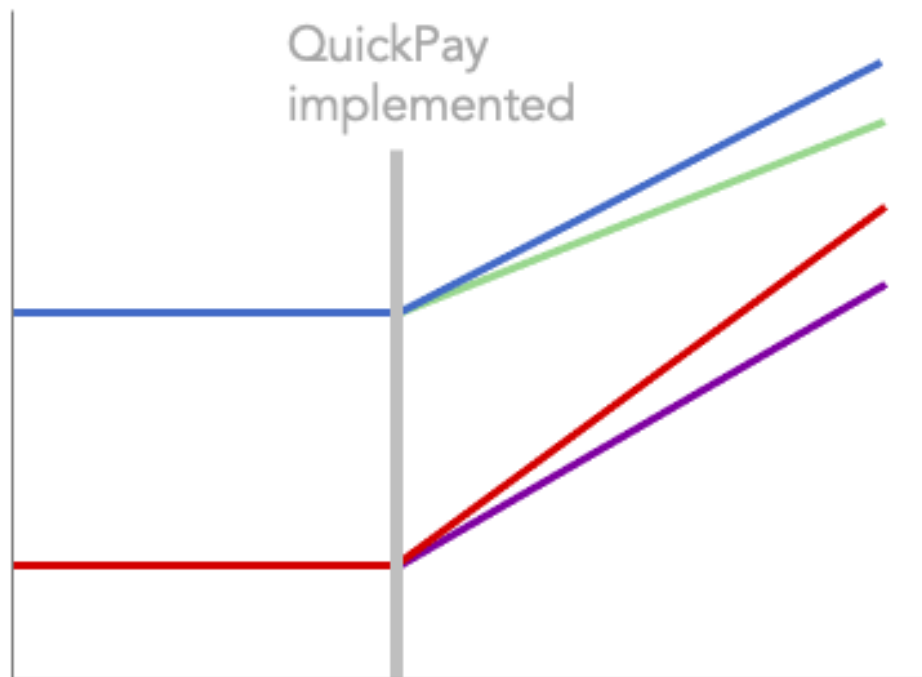
SEs are robust and clustered at the project level.

## 5 Competition

$$Competition_i = \begin{cases} 1, & \text{if project was subject to full and open competition} \\ \text{(extent competed code is not B, C, G, E, or "")} \\ 0, & \text{otherwise} \end{cases}$$

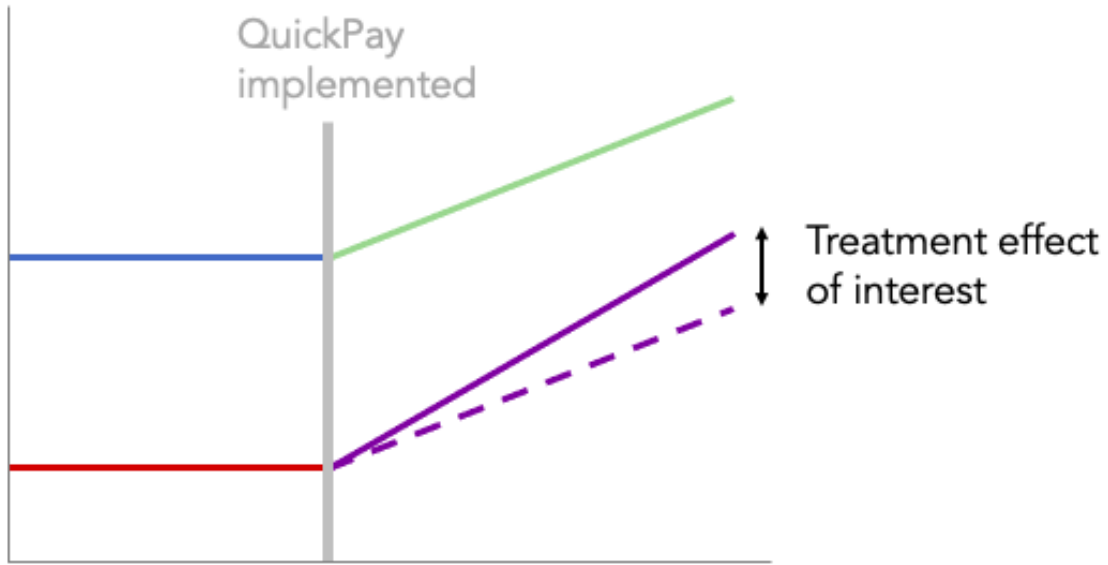
### Hypothesis:

- QuickPay increased competition for small projects.
- This led to more aggressive bids. That is, contractors quoted unrealistically small timelines for the projects.
- As a result, we should see “artificial delays” on these projects as they revert to their realistic timelines later.
- **Note:** This hypothesis only applies to projects that were signed after QuickPay. See Figure below for different groups in the sample.



Large projects signed before QuickPay  
Large projects signed after QuickPay  
Small projects signed before QuickPay  
Small projects signed after QuickPay

We, therefore, need the effect coming from projects that were signed after QuickPay.



Large projects signed before QuickPay  
 Large projects signed after QuickPay  
 Small projects signed before QuickPay  
 Small projects signed after QuickPay

## 5.1 Impact on bids

For competitively awarded projects, we run the following:

$$\begin{aligned}
 NumberOfBids_{it} = & \beta_0 + \beta_1 Treat_i + \beta_2 Post_t + \beta_3 (Treat_i \times Post_t) \\
 & + X_i + (Post_t \times X_i) + \mu_t + \lambda_{task} + \epsilon_{it}
 \end{aligned}$$

Table 3: Effect of Competition After QuickPay: Quickpay 2009-2011

	<i>NumberOfBids<sub>it</sub></i>			
	(1)	(2)	(3)	(4)
<i>Treat<sub>i</sub></i>	0.11 (0.11)	0.28*** (0.09)	0.28*** (0.09)	0.58*** (0.07)
<i>Post<sub>t</sub></i>	0.004 (0.07)	-0.43*** (0.12)		
<i>Treat<sub>i</sub> × Post<sub>t</sub></i>	0.25** (0.12)	0.41*** (0.12)	0.41*** (0.13)	0.22** (0.09)
Constant	5.43*** (0.10)	4.57*** (0.10)		
Duration, Budget	No	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget)</i>	No	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes
Task Fixed Effects	No	No	No	Yes
Observations	371,290	348,912	348,912	348,912
R <sup>2</sup>	0.0001	0.002	0.002	0.37
Adjusted R <sup>2</sup>	0.0001	0.002	0.002	0.36

Note:

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

Sample restricted to fully competed projects.

## 5.2 Impact on delays

Define

$$StartedAfterQP_i = \begin{cases} 1, & \text{if project was signed after QuickPay} \\ 0, & \text{otherwise} \end{cases}$$

### 5.2.1 Subsample Model

For a subsample of competitive or noncompetitive projects:

$$Delay_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 StartedAfterQP_i + \beta_3 Post_t + \beta_4 (Treat_i \times Post_t \times StartedAfterQP_i) + \epsilon_{it}$$

- According to our hypothesis,  $\beta_4$  should be positive and significant for competitive projects, and insignificant for non-competitive projects.
- In the following regressions, we also control for the project's age. Project's age is defined as the number of quarters since it first showed up in the sample. We include the terciles of project's age as a control variable.

Table 4: Subsample of Competitive Projects: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	-6.26*** (0.50)	-4.12*** (0.50)	-3.90*** (0.50)	-0.97* (0.53)	-2.25 (1.79)
<i>SignedAfterQP<sub>i</sub></i>	-19.40*** (0.78)	-21.24*** (0.81)	-37.23*** (0.97)	-33.58*** (0.97)	-34.53*** (1.06)
<i>Post<sub>t</sub></i>	19.61*** (0.47)	16.38*** (0.99)			
<i>Treat<sub>i</sub> × SignedAfterQP<sub>i</sub> × Post<sub>t</sub></i>	5.97*** (0.98)	2.77*** (0.99)	3.34*** (1.00)	2.01** (1.00)	5.10*** (1.17)
Constant	32.80*** (0.37)	35.52*** (0.69)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub></i> × (Duration, Budget, Bids)	No	Yes	Yes	Yes	Yes
Project age	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	144,011	128,428	128,428	128,428	128,428
R <sup>2</sup>	0.01	0.03	0.05	0.07	0.13
Adjusted R <sup>2</sup>	0.01	0.03	0.05	0.06	0.06

*Note:*

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

Sample restricted to fully competed projects.

Table 5: Subsample of Non-competitive Projects: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	2.01* (1.11)	4.09*** (1.14)	4.21*** (1.14)	-0.63 (1.40)	-1.03 (4.11)
<i>SignedAfterQP<sub>i</sub></i>	-15.13*** (1.72)	-17.98*** (1.78)	-37.41*** (2.17)	-37.36*** (2.25)	-39.23*** (2.66)
<i>Post<sub>t</sub></i>	20.62*** (1.11)	28.80*** (5.98)			
<i>Treat<sub>i</sub> × SignedAfterQP<sub>i</sub> × Post<sub>t</sub></i>	-3.34 (2.16)	-4.42** (2.20)	-3.94* (2.24)	-2.04 (2.33)	0.86 (2.98)
Constant	29.65*** (0.92)	18.80*** (5.71)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes	Yes	Yes
Project age	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	29,889	27,210	27,210	27,210	27,210
R <sup>2</sup>	0.01	0.02	0.05	0.09	0.17
Adjusted R <sup>2</sup>	0.01	0.02	0.05	0.06	0.04

Note:

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

Sample restricted to non-competed projects.

### 5.2.2 Combined Model

- The model below will give the same result as subsample analysis, but also allow us to test whether difference between the two treatment effects is statistically significant.

$$\begin{aligned}
Delay_{it} = & \beta_0 + \beta_1 Treat_i + \beta_2 StartedAfterQP_i + \beta_3 Post_t + \beta_4 Competitive_i \\
& + \beta_5 (Treat_i \times Competitive_i) + \beta_6 (Post_t \times Competitive_i) \\
& + \beta_7 (StartedAfterQP_i \times Competitive_i) + \beta_8 (Treat_i \times Post_t \times StartedAfterQP_i) \\
& + \beta_9 (Treat_i \times Post_t \times StartedAfterQP_i \times Competitive_i) + \epsilon_{it}
\end{aligned}$$

- According to our hypothesis,  $\beta_9$  should be positive and significant. That is the difference in treatment effect for competitive and non-competitive projects is significant.



Table 6: Effect of Competition After QuickPay: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	2.01* (1.11)	3.94*** (1.14)	4.00*** (1.14)	1.80 (1.19)	-0.79 (2.26)
<i>StartedAfterQP<sub>i</sub></i>	-15.13*** (1.72)	-18.13*** (1.76)	-35.18*** (1.85)	-34.24*** (1.86)	-36.26*** (2.09)
<i>Competitive<sub>i</sub></i>	3.15*** (0.99)	5.76*** (1.04)	5.37*** (1.04)	2.66** (1.11)	4.00** (1.61)
<i>Post<sub>t</sub></i>	20.62*** (1.11)	17.75*** (1.41)			
<i>Treat<sub>i</sub> × Competitive<sub>i</sub></i>	-8.26*** (1.22)	-8.07*** (1.24)	-7.89*** (1.25)	-2.66** (1.30)	-0.38 (2.05)
<i>Post<sub>t</sub> × Competitive<sub>i</sub></i>	-1.00 (1.21)	-1.74 (1.32)	-2.46* (1.35)	-2.78** (1.36)	-4.34*** (1.49)
<i>StartedAfterQP<sub>i</sub> × Competitive<sub>i</sub></i>	-4.27** (1.89)	-3.10 (1.92)	-2.49 (1.96)	0.48 (1.96)	1.98 (2.21)
<i>Treat<sub>i</sub> × StartedAfterQP<sub>i</sub> × Post<sub>t</sub></i>	-3.34 (2.16)	-4.43** (2.20)	-3.96* (2.23)	-2.74 (2.22)	-0.53 (2.60)
<i>Treat<sub>i</sub> × StartedAfterQP<sub>i</sub> × Post<sub>t</sub> × Competitive<sub>i</sub></i>	9.31*** (2.37)	7.27*** (2.41)	7.39*** (2.45)	4.58* (2.44)	4.87* (2.84)
Constant	29.65*** (0.92)	29.76*** (1.11)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes	Yes	Yes
Project age	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	173,900	155,638	155,638	155,638	155,638
R <sup>2</sup>	0.01	0.03	0.05	0.07	0.13
Adjusted R <sup>2</sup>	0.01	0.03	0.05	0.06	0.06

Note:

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

## 6 Impact of Firm's Financial Constraints

### 6.1 Contract Financing

$$CF_i = \begin{cases} 1, & \text{if project } i \text{ receives contract financing} \\ 0, & \text{otherwise} \end{cases}$$

$$\begin{aligned}
Delay_{it} = & \alpha + \beta_0 Treat_i + \beta_1 Post_t + \beta_2 (Treat_i \times Post_t) \\
& + \beta_3 CF_i + \beta_4 (CF_i \times Post_t) + \beta_5 (Treat_i \times Post_t \times CF_i) \\
& + X_i + (Post_t \times X_i) + \mu_t + \theta_{firm} + \lambda_{task} + \epsilon_{it}
\end{aligned}$$

Table 7: Effect of Contract Financing: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	-6.12*** (0.50)	-4.93*** (0.53)	-5.03*** (0.53)	-2.97*** (0.56)	-2.89* (1.59)
<i>Post<sub>t</sub></i>	13.00*** (0.57)	6.91*** (0.95)			
<i>Treat<sub>i</sub> × Post<sub>t</sub></i>	1.53** (0.78)	2.30*** (0.86)	2.30*** (0.88)	3.21*** (0.88)	5.90*** (1.01)
<i>CF<sub>i</sub></i>	-3.97*** (0.61)	-6.52*** (0.63)	-6.69*** (0.63)	-4.11*** (0.66)	-4.76*** (0.82)
<i>Post<sub>t</sub> × CF<sub>i</sub></i>	0.72 (1.13)	-0.49 (1.15)	-0.90 (1.17)	-0.08 (1.17)	-0.37 (1.32)
<i>Post<sub>t</sub> × CF<sub>i</sub> × Treat<sub>i</sub></i>	9.24*** (1.38)	6.71*** (1.39)	7.62*** (1.41)	4.47*** (1.42)	3.70** (1.67)
Constant	33.64*** (0.38)	51.78*** (0.62)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	173,900	155,638	155,638	155,638	155,638
R <sup>2</sup>	0.01	0.02	0.03	0.05	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.05	0.05

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

## 6.2 Receives Financial Aid

$$FinancialAid = \begin{cases} 1, & \text{if firm receives grants or is a c8A participant} \\ 0, & \text{otherwise} \end{cases}$$

$$\begin{aligned}
Delay_{it} = & \alpha + \beta_0 Treat_i + \beta_1 Post_t + \beta_2 (Treat_i \times Post_t) + \beta_3 FinancialAid \\
& + \beta_4 (FinancialAid \times Post_t) + \beta_5 (Treat_i \times Post_t \times FinancialAid) \\
& + X_i + (Post_t \times X_i) + \mu_t + \theta_{firm} + \lambda_{task} + \epsilon_{it}
\end{aligned}$$

Table 8: Effect of Grants or C8A Participant: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	-6.96*** (0.51)	-5.71*** (0.54)	-5.80*** (0.54)	-3.41*** (0.57)	-2.63* (1.59)
<i>Post<sub>t</sub></i>	12.89*** (0.53)	6.36*** (0.93)			
<i>Treat<sub>i</sub> × Post<sub>t</sub></i>	3.43*** (0.77)	3.19*** (0.84)	3.44*** (0.85)	3.84*** (0.86)	5.57*** (0.99)
<i>FinancialAid</i>	5.72*** (0.70)	4.01*** (0.74)	3.95*** (0.74)	2.88*** (0.77)	0.45 (1.42)
<i>Post<sub>t</sub> × FinancialAid</i>	1.94 (1.61)	3.33** (1.69)	3.41** (1.72)	4.50*** (1.73)	3.93* (2.12)
<i>Post<sub>t</sub> × FinancialAid × Treat<sub>i</sub></i>	-1.80 (1.73)	0.73 (1.79)	0.44 (1.82)	-0.99 (1.84)	2.75 (2.50)
Constant	32.42*** (0.37)	50.34*** (0.62)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	173,900	155,638	155,638	155,638	155,638
R <sup>2</sup>	0.01	0.02	0.03	0.05	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.05	0.05

Note:

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

### 6.3 Receives Contracts and Financial Aid

$$CFA = \begin{cases} 1, & \text{if firm receives "contracts and grants"} \\ & \text{or grants or is a c8A participant} \\ 0, & \text{otherwise} \end{cases}$$

$$\begin{aligned} Delay_{it} = & \alpha + \beta_0 Treat_i + \beta_1 Post_t + \beta_2 (Treat_i \times Post_t) + \beta_3 CFA \\ & + \beta_4 (CFA \times Post_t) + \beta_5 (Treat_i \times Post_t \times CFA) \\ & + X_i + (Post_t \times X_i) + \mu_t + \theta_{firm} + \lambda_{task} + \epsilon_{it} \end{aligned}$$

Table 9: Effect of Contracts, Grants, or C8A Participant: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	-6.68*** (0.51)	-5.45*** (0.53)	-5.53*** (0.54)	-3.15*** (0.56)	-2.71* (1.59)
<i>Post<sub>t</sub></i>	12.17*** (0.55)	5.56*** (0.96)			
<i>Treat<sub>i</sub> × Post<sub>t</sub></i>	4.19*** (0.79)	3.63*** (0.86)	3.90*** (0.87)	4.40*** (0.87)	5.84*** (1.03)
<i>CFA</i>	4.90*** (0.62)	2.89*** (0.65)	2.65*** (0.66)	1.62** (0.68)	-5.92*** (1.80)
<i>Post<sub>t</sub> × CFA</i>	3.91*** (1.21)	4.28*** (1.27)	4.47*** (1.29)	5.68*** (1.30)	5.83*** (1.64)
<i>Post<sub>t</sub> × CFA × Treat<sub>i</sub></i>	-4.04*** (1.38)	-0.23 (1.43)	-0.56 (1.45)	-2.13 (1.48)	1.61 (2.16)
Constant	32.18*** (0.37)	50.27*** (0.63)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	173,900	155,638	155,638	155,638	155,638
R <sup>2</sup>	0.01	0.02	0.03	0.05	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.05	0.05

Note:

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

## 7 Firm's rank order

- Consider a project  $i$  of firm  $f$  in quarter  $t$ .
- Let  $\Pi_{f,2010}$  denote all projects of firm  $f$  in Fiscal Year 2010.
- Define  $\rho_f = \sum_{i \in \Pi_{f,2010}} (Treat_i \times FAO_{if}) / Sales_{f,2010}$ .
- $\rho_f$  is the fraction of revenue a firm earned from small government projects in Fiscal Year 2010.
- Let  $Rank_f = r(\rho_f) / N$  where  $r(\rho_f)$  is the rank statistic of  $\rho_f$  and  $N$  = number of firms. For example,  $r(\rho_f) = 1$  if  $\rho_f = \min(\rho_1, \rho_2, \dots, \rho_N)$ .
- Put simply,  $Rank_f$  is a firm's rank order based on the fraction of revenue it earned from small government projects in FY 2010.

### 7.1 Portfolio Effects: Discrete

- See Jie's notes for details.

- Assumption: Parallel trends between small projects of firms in different terciles with pooled sample large projects. May not hold. Need to include firm specific control or at least plot the trends.
- Let  $Rank_f^{(k)}$  be an indicator for firm being in the k-th tercile of  $Rank$ . Define:
  - $Medium_i = Treat_i * Rank_f^{(2)}$
  - $High_i = Treat_i * Rank_f^{(3)}$

$$Delay_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 Medium_i + \beta_3 High_i + \beta_4 Post_t + \beta_5 (Treat_i \times Post_t) + \beta_6 (Medium_i \times Post_t) + \beta_7 (High_i \times Post_t) + \epsilon_{it}$$

Table 10: Discrete Portfolio Effects: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	2.85** (1.37)	−0.51 (1.54)	−0.38 (1.55)	0.37 (1.64)	−6.90 (4.47)
<i>Medium<sub>i</sub></i>	−2.95** (1.40)	−1.14 (1.56)	−1.35 (1.57)	−0.64 (1.63)	10.91* (6.15)
<i>High<sub>i</sub></i>	−3.25** (1.31)	0.11 (1.49)	−0.04 (1.50)	1.07 (1.58)	−1.79 (6.03)
<i>Post<sub>t</sub></i>	15.67*** (1.05)	6.86*** (1.83)			
<i>Treat<sub>i</sub> × Post<sub>t</sub></i>	−2.42 (2.04)	2.15 (2.36)	1.26 (2.39)	1.32 (2.43)	7.32** (3.16)
<i>Treat<sub>i</sub> × Post<sub>t</sub> × Medium<sub>i</sub></i>	4.30** (2.09)	1.56 (2.38)	2.33 (2.41)	2.47 (2.45)	0.10 (3.22)
<i>Treat<sub>i</sub> × Post<sub>t</sub> × High<sub>i</sub></i>	6.74*** (1.97)	3.44 (2.28)	4.15* (2.31)	3.57 (2.35)	−1.28 (3.07)
Constant	27.08*** (0.71)	46.30*** (1.16)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	71,753	63,216	63,216	63,216	63,216
R <sup>2</sup>	0.01	0.02	0.03	0.06	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.04	0.04

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

## 7.2 Portfolio Effects: Continuous

- See Jie's notes for details.

- Define  $\theta_i = Treat_i * Rank_f$

$$Delay_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 \theta_i + \beta_3 \theta_i^2 + \beta_4 Post_t + \beta_5 (Treat_i \times Post_t) + \beta_6 (\theta_i \times Post_t) + \beta_7 (\theta_i^2 \times Post_t) + \epsilon_{it}$$

Table 11: Continuous Portfolio Effects: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
<i>Treat<sub>i</sub></i>	-1.44 (2.52)	-4.54 (2.79)	-4.12 (2.80)	-2.25 (2.88)	-19.01** (8.36)
$\theta_i$	15.63* (8.14)	12.24 (8.85)	11.06 (8.89)	8.21 (9.06)	92.44*** (34.90)
$\theta_i^2$	-16.17** (6.56)	-8.85 (7.11)	-8.10 (7.15)	-5.07 (7.30)	-88.48*** (31.25)
<i>Post<sub>t</sub></i>	15.67*** (1.05)	6.85*** (1.83)			
<i>Treat<sub>i</sub> × Post<sub>t</sub></i>	-3.83 (3.74)	2.64 (4.31)	1.05 (4.38)	0.34 (4.45)	9.39 (5.79)
$\theta_i \times Post_t$	4.16 (12.19)	-3.40 (13.75)	-0.02 (13.98)	3.49 (14.13)	-4.73 (17.63)
$\theta_i^2 \times Post_t$	4.91 (9.87)	6.92 (11.09)	4.92 (11.27)	1.51 (11.38)	1.46 (13.78)
Constant	27.08*** (0.71)	46.30*** (1.16)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub></i> × (Duration, Budget, Bids)	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	71,753	63,216	63,216	63,216	63,216
R <sup>2</sup>	0.01	0.02	0.03	0.06	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.04	0.04

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

## 8 Firm's rank order : Alternate model

### 8.1 Continuous model

- We have  $\theta_{if} = Treat_i * Rank_f$

$$Delay_{ift} = \beta_0 + \beta_1\theta_{if} + \beta_2(\theta_{if} \times Post_t) + \beta_3Post_t + \beta_4Rank_f + \epsilon_{ift}$$

- Consider a firm with  $Rank_f = k$ . Then, we have
  - Large + Before =  $\beta_0 + \beta_4k$
  - Large + After =  $\beta_0 + \beta_3 + \beta_4k$
  - Small + Before =  $\beta_0 + \beta_1k + \beta_4k$
  - Small + After =  $\beta_0 + \beta_1k + \beta_2k + \beta_3 + \beta_4k$
  - Treatment effect:  $\beta_2k$

**Interpretation:**

- Treatment effect is  $\beta_2k$  for a firm that received a proportion  $k$  of its revenue from small projects.
- In other words, for a firm earning  $k$  proportion of revenue from small projects, Quickpay increased delays on small projects by  $\beta_3k$  days.

**Assumption:** Parallel trends between large and small projects of the same firm.

Table 12: Continuous Portfolio Effects: Quickpay 2009-2011

	Delay <sub>it</sub> (in days)				
	(1)	(2)	(3)	(4)	(5)
$\theta_{if}$	−4.81* (2.60)	−6.34** (2.63)	−5.86** (2.64)	−3.31 (2.66)	−4.43 (3.59)
$Rank_f$	4.98* (2.93)	7.22** (2.95)	6.53** (2.97)	5.66* (2.99)	
$Post_t$	14.74*** (0.96)	6.92*** (1.68)			
$\theta_{if} \times Post_t$	4.91*** (1.40)	5.66*** (1.54)	5.60*** (1.56)	5.24*** (1.58)	6.23*** (1.75)
Constant	26.88*** (0.77)	44.82*** (1.14)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
$Post_t \times$ (Duration, Budget, Bids)	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	71,753	63,216	63,216	63,216	63,216
R <sup>2</sup>	0.01	0.02	0.03	0.06	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.04	0.04

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

## 8.2 Continuous Quadratic Model

- We have  $\theta_{if} = Treat_i * Rank_f$

$$Delay_{ift} = \beta_0 + \beta_1\theta_{if} + \beta_2\theta_{if}^2 + \beta_3(\theta_{if} \times Post_t) + \beta_4(\theta_{if}^2 \times Post_t) + \beta_5Post_t + \beta_6Rank_f + \epsilon_{ift}$$

- Consider a firm with  $Rank_f = k$ . Then, we have
  - Large + Before =  $\beta_0 + \beta_6 k$
  - Large + After =  $\beta_0 + \beta_5 + \beta_6 k$
  - Small + Before =  $\beta_0 + \beta_1 k + \beta_2 k^2 + \beta_6 k$
  - Small + After =  $\beta_0 + \beta_1 k + \beta_2 k^2 + \beta_3 k + \beta_4 k^2 + \beta_5 + \beta_6 k$
  - Treatment effect:  $\beta_3 k + \beta_4 k^2$

**Interpretation:** \* One unit increase in rank  $k$  increases treatment effect by  $\beta_3 + 2k\beta_4$ .

**Assumption:** Parallel trends between large and small projects of the same firm.

Table 13: Continuous Portfolio Effects: Quickpay 2009-2011

	<i>Delay<sub>it</sub></i> (in days)				
	(1)	(2)	(3)	(4)	(5)
$\theta_{if}$	8.16* (4.51)	−3.96 (4.98)	−3.59 (5.02)	−0.81 (5.21)	26.72 (18.44)
$\theta_{if}^2$	−15.84*** (4.56)	−2.95 (5.11)	−2.68 (5.15)	−3.17 (5.38)	−38.43* (21.55)
$Rank_f$	7.00** (3.05)	7.62** (3.06)	6.76** (3.08)	6.19** (3.10)	
$Post_t$	15.33*** (1.01)	7.03*** (1.78)			
$\theta_{if} \times Post_t$	−6.42 (6.39)	4.03 (7.32)	2.96 (7.43)	4.50 (7.52)	20.71** (8.88)
$\theta_{if}^2 \times Post_t$	12.31* (6.73)	1.79 (7.75)	2.87 (7.87)	0.81 (7.96)	−15.74* (9.43)
Constant	25.79*** (0.84)	44.57*** (1.23)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
$Post_t \times$ (Duration, Budget, Bids)	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	71,753	63,216	63,216	63,216	63,216
R <sup>2</sup>	0.01	0.02	0.03	0.06	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.04	0.04

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

### 8.3 Discrete Model

- Let  $Rank_f^{(k)}$  be an indicator for firm being in the k-th tercile of  $Rank$ . Define:
  - $Medium_{if} = Treat_i * Rank_f^{(2)}$  and
  - $High_{if} = Treat_i * Rank_f^{(3)}$



$$\begin{aligned}
Delay_{ift} = & \beta_0 + \beta_1 Low_{if} + \beta_2 Medium_{if} + \beta_3 High_{if} + \\
& \beta_4 Rank_f^{(2)} + \beta_5 Rank_f^{(3)} + \beta_6 Post_t + \\
& \beta_7 (Low_{if} \times Post_t) + \beta_8 (Medium_{if} \times Post_t) + \beta_9 (High_{if} \times Post_t) + \epsilon_{ift}
\end{aligned}$$

- Firms in lowest tercile:
  - Large + before =  $\beta_0$
  - Large + after =  $\beta_0 + \beta_6$
  - Small + before =  $\beta_0 + \beta_1$
  - Small + after =  $\beta_0 + \beta_1 + \beta_6 + \beta_7$
  - Treatment effect =  $\beta_7$
- Firms in medium tercile:
  - Large + before =  $\beta_0 + \beta_4$
  - Large + after =  $\beta_0 + \beta_4 + \beta_6$
  - Small + before =  $\beta_0 + \beta_2 + \beta_4$
  - Small + after =  $\beta_0 + \beta_2 + \beta_4 + \beta_6 + \beta_8$
  - Treatment effect =  $\beta_8$
- Firms in highest tercile:
  - Large + before =  $\beta_0 + \beta_5$
  - Large + after =  $\beta_0 + \beta_5 + \beta_6$
  - Small + before =  $\beta_0 + \beta_3 + \beta_5$
  - Small + after =  $\beta_0 + \beta_3 + \beta_5 + \beta_6 + \beta_9$
  - Treatment effect =  $\beta_9$

**Assumption:** Parallel trends between large and small projects of firms in the same tercile.

Table 14: Discrete Portfolio Effects: Quickpay 2009-2011

	<i>Dependent variable:</i>				
	<i>Delay<sub>it</sub> (in days)</i>				
	(1)	(2)	(3)	(4)	(5)
<i>Low<sub>if</sub></i>	3.04** (1.38)	−0.16 (1.55)	−0.08 (1.56)	0.78 (1.65)	−6.90 (4.47)
<i>Medium<sub>if</sub></i>	1.68 (2.78)	−2.38 (2.88)	−1.43 (2.91)	−0.05 (2.89)	4.02 (4.27)
<i>High<sub>if</sub></i>	−10.12*** (3.71)	−10.78*** (3.59)	−10.61*** (3.58)	−10.72*** (3.54)	−8.69** (4.15)
<i>Rank<sub>f</sub><sup>(2)</sup></i>	−1.59 (2.70)	1.08 (2.77)	−0.01 (2.80)	0.17 (2.81)	
<i>Rank<sub>f</sub><sup>(3)</sup></i>	9.92*** (3.69)	10.72*** (3.55)	10.48*** (3.55)	12.57*** (3.50)	
<i>Post<sub>t</sub></i>	15.64*** (1.05)	6.84*** (1.83)			
<i>Low<sub>if</sub> × Post<sub>t</sub></i>	−2.39 (2.04)	2.18 (2.36)	1.28 (2.39)	1.33 (2.43)	7.32** (3.16)
<i>Medium<sub>if</sub> × Post<sub>t</sub></i>	1.91 (1.56)	3.75** (1.74)	3.61** (1.76)	3.81** (1.79)	7.42*** (2.03)
<i>High<sub>if</sub> × Post<sub>t</sub></i>	4.35*** (1.38)	5.64*** (1.52)	5.44*** (1.54)	4.89*** (1.56)	6.04*** (1.71)
Constant	26.88*** (0.72)	45.95*** (1.17)			
Duration, Budget, Bids	No	Yes	Yes	Yes	Yes
<i>Post<sub>t</sub> × (Duration, Budget, Bids)</i>	No	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	No	No	Yes	Yes	Yes
Task Fixed Effects	No	No	No	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes
Observations	71,753	63,216	63,216	63,216	63,216
R <sup>2</sup>	0.01	0.02	0.03	0.06	0.12
Adjusted R <sup>2</sup>	0.01	0.02	0.03	0.04	0.04

Note:

\*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

Each observation is a project-quarter.

SEs are robust and clustered at the project level.

## 9 Other Proxies for Treatment intensity or Portfolio effects

### 9.1 Proxy 1: Revenue from small projects

- We defined  $\rho_f$  as the share of revenue a firm received from small projects in fiscal year 2010.

- The numerator of  $\rho_f$  is the sum of all federal obligations from small projects of a firm in fiscal year 2010. Because obligations can be negative, the sum can be zero or negative even if the firm held substantial number of small projects.
- In the previous section, we ranked the values of  $\rho_f$ . But this makes interpretation somewhat tricky. The minimum rank for each firm is now  $1/N$  and it is never zero. What does a unit increase in Rank mean?
- An alternative can be to simply scale the values of  $\rho_f$  to between 0 and 1. That is, for a firm A, we define  $Share_A = (\rho_A - \min(\rho_f)) / (\max(\rho_f) - \min(\rho_f))$ .
  - Suppose  $\rho_A = -1, \max(\rho_f) = 3, \min(\rho_f) = -2$ . Then,  $Share_A = (-1 - (-2)) / (3 - (-2)) = 1/5$ .
  - The max share will be 1 and min share will be 0.
- Setting aside measurement issues described earlier, we have:
  - $Share_f = 0$  represents a firm getting no revenue from small projects.
  - $Share_f = 1$  represents a firm getting its entire revenue from small projects.

## 9.2 Proxy 2: Ratio of small projects

- For firm  $f$ , define  $Share_f = \frac{\text{Num of small projects in FY 2010}}{\text{Total num of projects in FY 2010}}$ .
- Same analysis as before but advantages:
  - Sample size: only firms excluded are new entrants to government projects.
  - No measurement problem.  $Share_f$  will be zero for firms with no small projects, and one for firms with only small projects.
  - We can control for differences across firms through fixed effects. This will be less of an issue here because we will have enough observations.