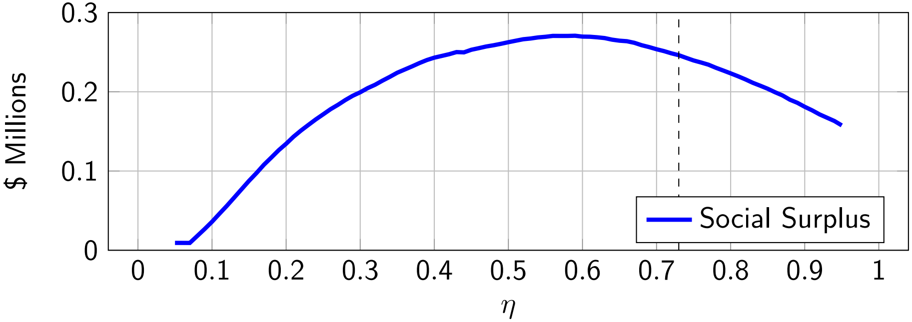
Intensity of Competition: The Effect of η

Increase $\eta \implies$ reduce holdup costs, but increase excessive Phase I effort

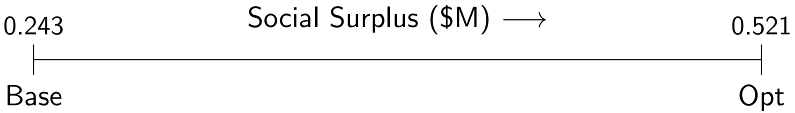


- Socially-optimal value of η is 0.5–0.6
- Holdup costs are low, so benefit to reducing other inefficiencies
- Net benefit is fairly small ($< 10\%$)

Aside: η is on the Pareto frontier between DOD and firm profits Laffer Curve

Would the DOD prefer to make these changes?

Consider $N_1 = 4$, with $\bar{N}_2 = 2$ as a baseline



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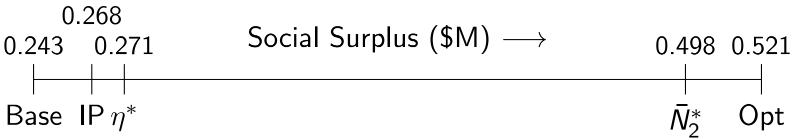

- IP sharing, reducing η, and increasing $\bar{N}_2$ all increase social surplus

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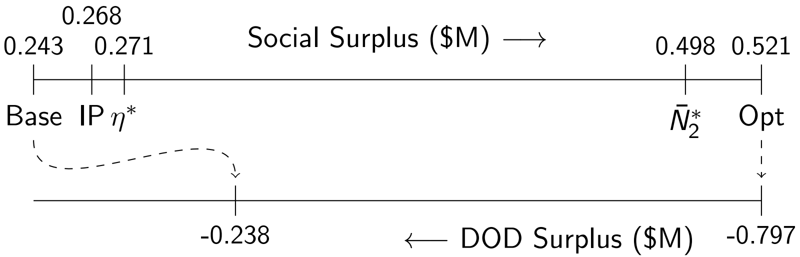

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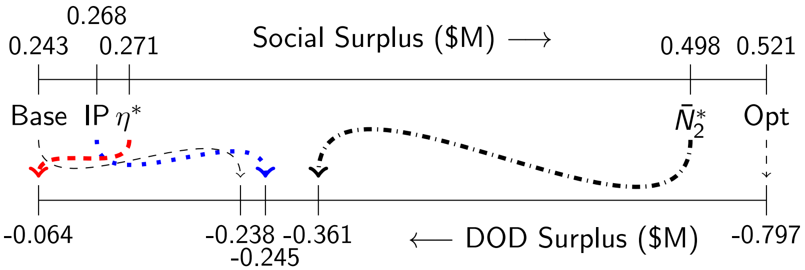

- IP sharing, reducing η, and increasing $\bar{N}_2$ all increase social surplus
- ... but most socially-optimal design changes are harmful for DOD
- DOD internalizes research costs but captures small portion of surplus

Most design changes benefit **either** planner **or** DOD

Conclusion

Developed a structural model of R&D contests

- ✓ Identified from research expenditures and procurement contracts
- ✓ Tractable estimation procedure applied to the DOD SBIR program

Increasing competition, reducing the share of the surplus given to the firms, and mandating that firms sharing IP can improve social outcomes

- Simple design changes can substantially improve social surplus
- But, usually detrimental to DOD profits

Future Work: Key aspects of the model apply to more general settings of multistage interactions

- FDA trials and product market competition; procurement of large construction projects; venture capital funding...

Monotonicity

We can write first term of the maximand as

$$\eta \int_{\underline{c}}^{v} \left[\int_0^{v-c} (v-c-s)\ dG(s) + (v-c)G(0) \right]\ dH(c;t)$$

$$= \eta \int_{\underline{c}}^{v} \left[-(v-c)G(0) + \int_0^{v-c} G(s)\ ds + (v-c)G(0) \right]\ dH(c;t)$$

$$= \left(\int_0^{v-c} G(s)\ ds \right) H(c,t) \Big|_{\underline{c}}^{v} + \int_{\underline{c}}^{v} G(v-c)H(c,t)\ dc = \int_{\underline{c}}^{v} G(v-c)H(c,t)\ dc.$$

The cross partial with respect to v and t is

$$G(0)\frac{\partial H(v,t)}{\partial t} + \int_{\underline{c}}^{v} g(v-c)\frac{\partial H(c,t)}{\partial t}\ dc,$$

and each term is positive.

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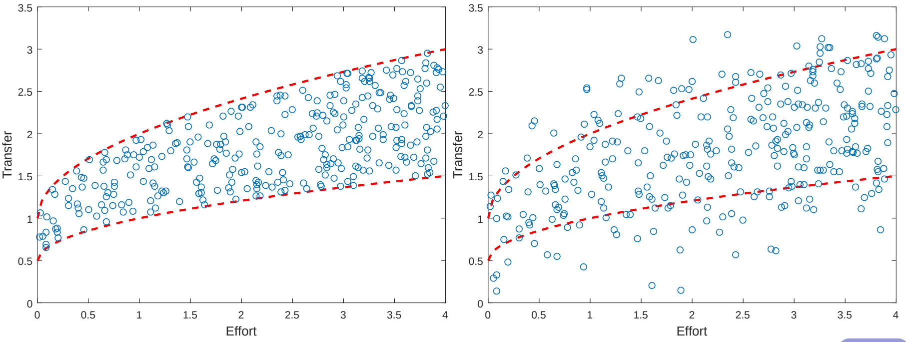
Role of the Unobserved Heterogeneity θ

Economic Interpretation: Higher value projects may also have higher costs, so it introduces a correlation in the model not captured by X

- They also have **higher surplus**, so it affects research incentives

Statistical Interpretation: Justify especially high/low values of transfer



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Early- and Late-Stage Competition

Total **change** from baseline ($N_1 = \bar{N}_2 = 1$), in millions of dollars

Social Surplus (Base = 0.144 \$M)				
	$\bar{N}_2 = 1$	$\bar{N}_2 = 2$	$\bar{N}_2 = 3$	$\bar{N}_2 = 4$
$N_1 = 2$	-0.024	0.129		
$N_1 = 3$	-0.022	0.099	0.247	
$N_1 = 4$	-0.019	0.102	0.218	0.354

DOD Profits (Base = -0.103 \$M)				
	$\bar{N}_2 = 1$	$\bar{N}_2 = 2$	$\bar{N}_2 = 3$	$\bar{N}_2 = 4$
$N_1 = 2$	-0.023	-0.094		
$N_1 = 3$	-0.024	-0.134	-0.180	
$N_1 = 4$	-0.026	-0.135	-0.222	-0.258

$N_1 \uparrow$, $\bar{N}_2$ –

- Phase I R&D per-firm $\downarrow$, but only other benefit is added draws of value
- DOD only captures 1/4 of this benefit

$N_1 \uparrow$, $\bar{N}_2 \uparrow$

- **Low substitutability** between projects in Phase II
- Social surplus and DOD profits change almost linearly

Planner prefers to invite contestants, DOD prefers to restrict entry

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Decomposing the Effect of Competition

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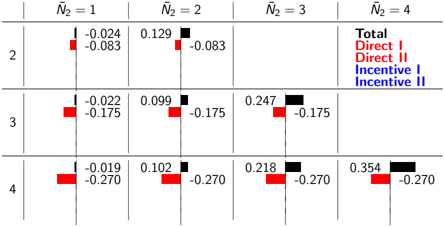

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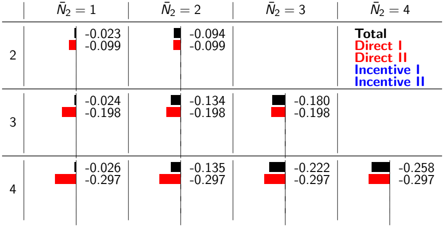
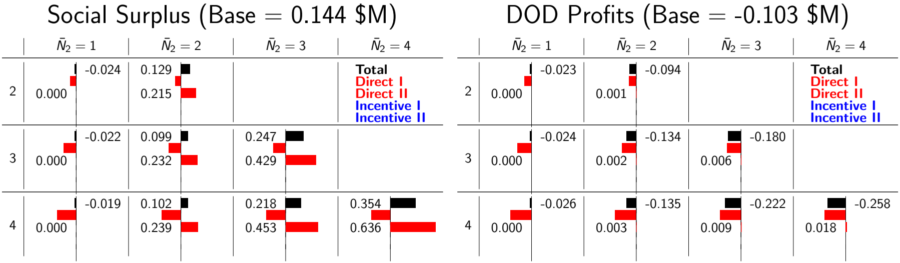


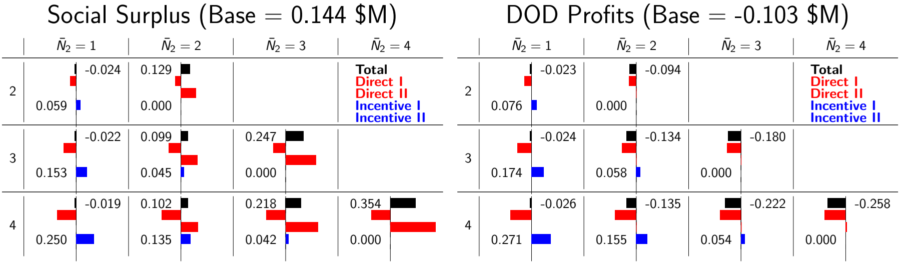
- **Direct effect of Phase I** < 0
- Benefit of added value draws in Phase I is low
- DOD only internalizes part of generated surplus $\longrightarrow$ larger in magnitude for DOD than social planner

Decomposing the Effect of Competition



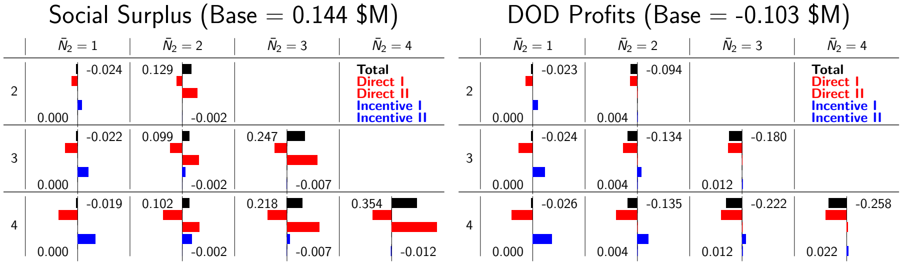
- **Direct effect of Phase II** > 0 for SS, ≈ 0 for DOD
- Additional chance at success is beneficial due to low substitutability
- ... but the DOD has to pay the full research costs
- **Key difference** between social planner and DOD

Decomposing the Effect of Competition



- **Incentive effect of Phase I** > 0
- Effort overprovided $\longrightarrow$ firms readjusting efforts downward is beneficial
- Slightly larger in magnitude for DOD

Decomposing the Effect of Competition



- **Incentive effect for Phase II** ≈ 0
- Competition is only relevant if both succeed, which is an unlikely event

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Increase η $\implies$

- more surplus created, but less to DOD $\longleftarrow$ **"DOD's Laffer Curve"**
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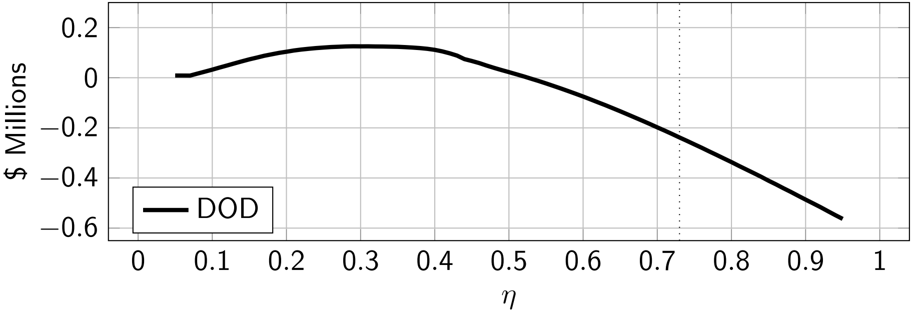

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- DOD profits (with research costs) can be improved significantly

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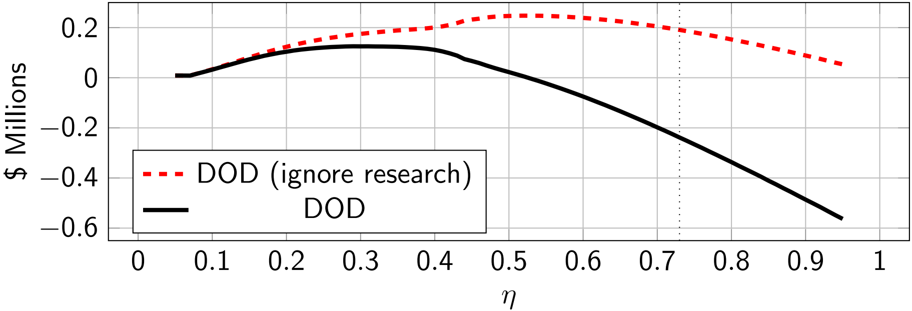

- $\eta \gtrsim 0.3$ is Pareto efficient
- DOD profits (with research costs) can be improved significantly
- DOD profits without research costs are closer to optimal

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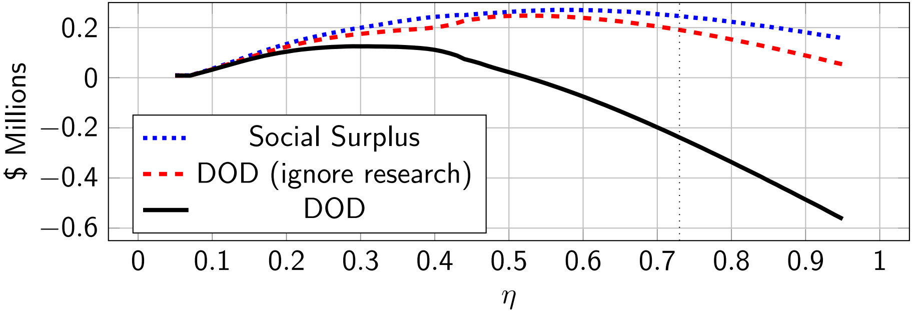

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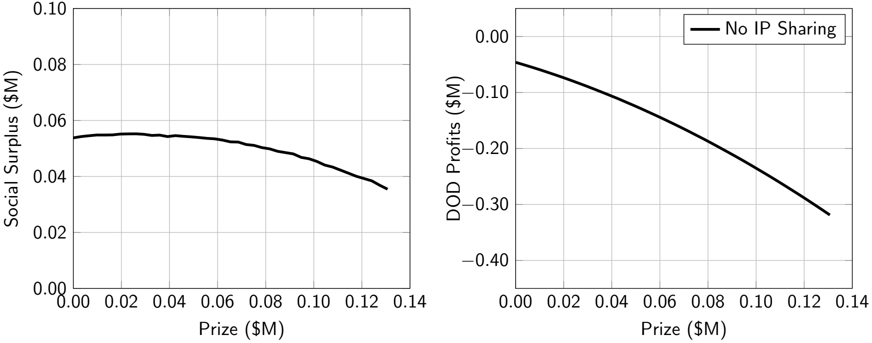
Decoupling Research and Delivery: DOD Profits



- Prizes can improve social surplus but reduce DOD profits
- ... but small at most because Phase I research is often overprovided

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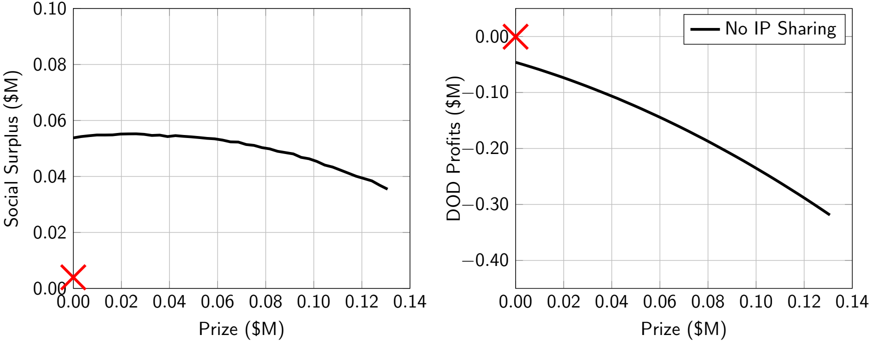

- IP sharing w/o prizes → Phase I research ↓ → DOD profits ↑ and SS ↓
- **Free-rider problems** from IP sharing → research is underprovided → prizes are beneficial

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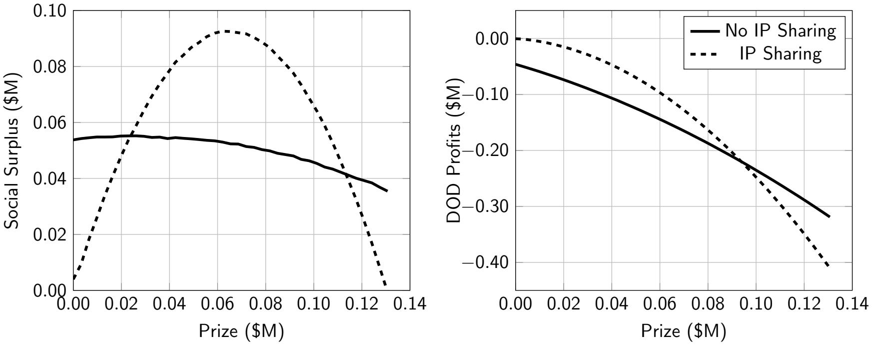

- IP sharing w/o prizes → Phase I research ↓ → DOD profits ↑ and SS ↓
- **Free-rider problems** from IP sharing → research is underprovided → prizes are beneficial
- Substantial social gains to (IP sharing + prizes) vs. baseline contest

▸ Back

IP Sharing

No Sharing		$K=0$		K^*_{SS}		
N_1	N_2	SS	DOD	$\mathbb{E}[K(\cdot)]$	SS	DOD
2	2	0.054	-0.046	0.026	0.055	-0.083
3	2	0.111	-0.135	0.000	0.111	-0.135
3	3	0.139	-0.160	0.000	0.139	-0.160
4	2	0.246	-0.238	0.000	0.246	-0.238
4	3	0.362	-0.325	0.000	0.362	-0.325
4	4	0.498	-0.361	0.000	0.498	-0.361

IP Sharing		$K=0$		K^*_{SS}			K_{IC}		
N_1	N_2	SS	DOD	$\mathbb{E}[K(\cdot)]$	SS	DOD	$\mathbb{E}[K(\cdot)]$	SS	DOD
2	2	0.004	-0.000	0.062	0.093	-0.103	0.131	-0.001	-0.410
3	2	0.162	-0.130	0.000	0.162	-0.130	0.099	0.047	-0.469
3	3	0.013	-0.000	0.073	0.264	-0.103	0.083	0.185	-0.445
4	2	0.268	-0.245	0.000	0.268	-0.245	0.041	0.212	-0.407
4	3	0.400	-0.342	0.000	0.400	-0.342	0.002	0.396	-0.353
4	4	0.647	-0.294	0.001	0.650	-0.296	0.001	0.602	-0.345

- A few instances where IP sharing and prizes can improve DOD profits and social surplus