Mechanics of Combinatorial Growth: Welfare Results

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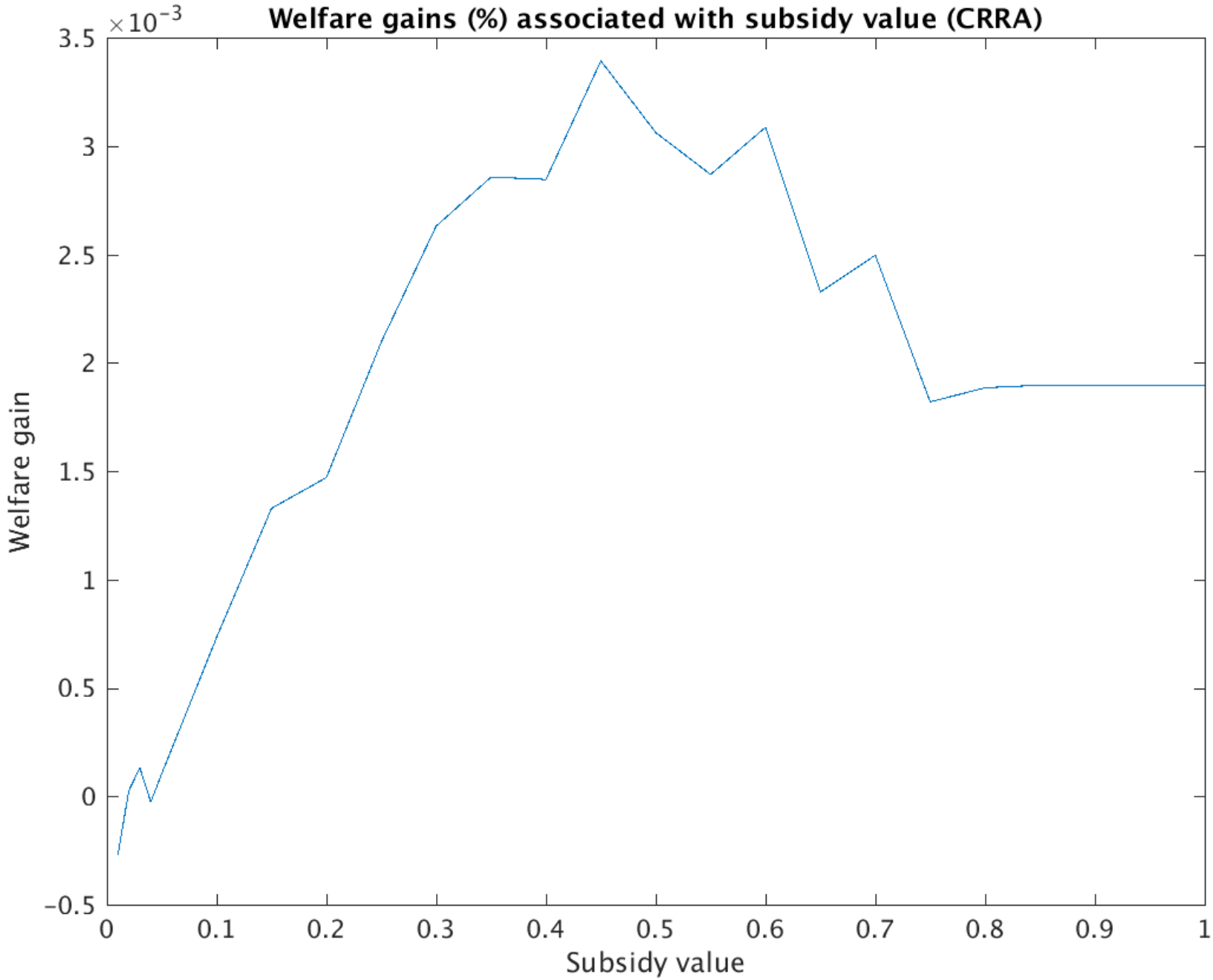
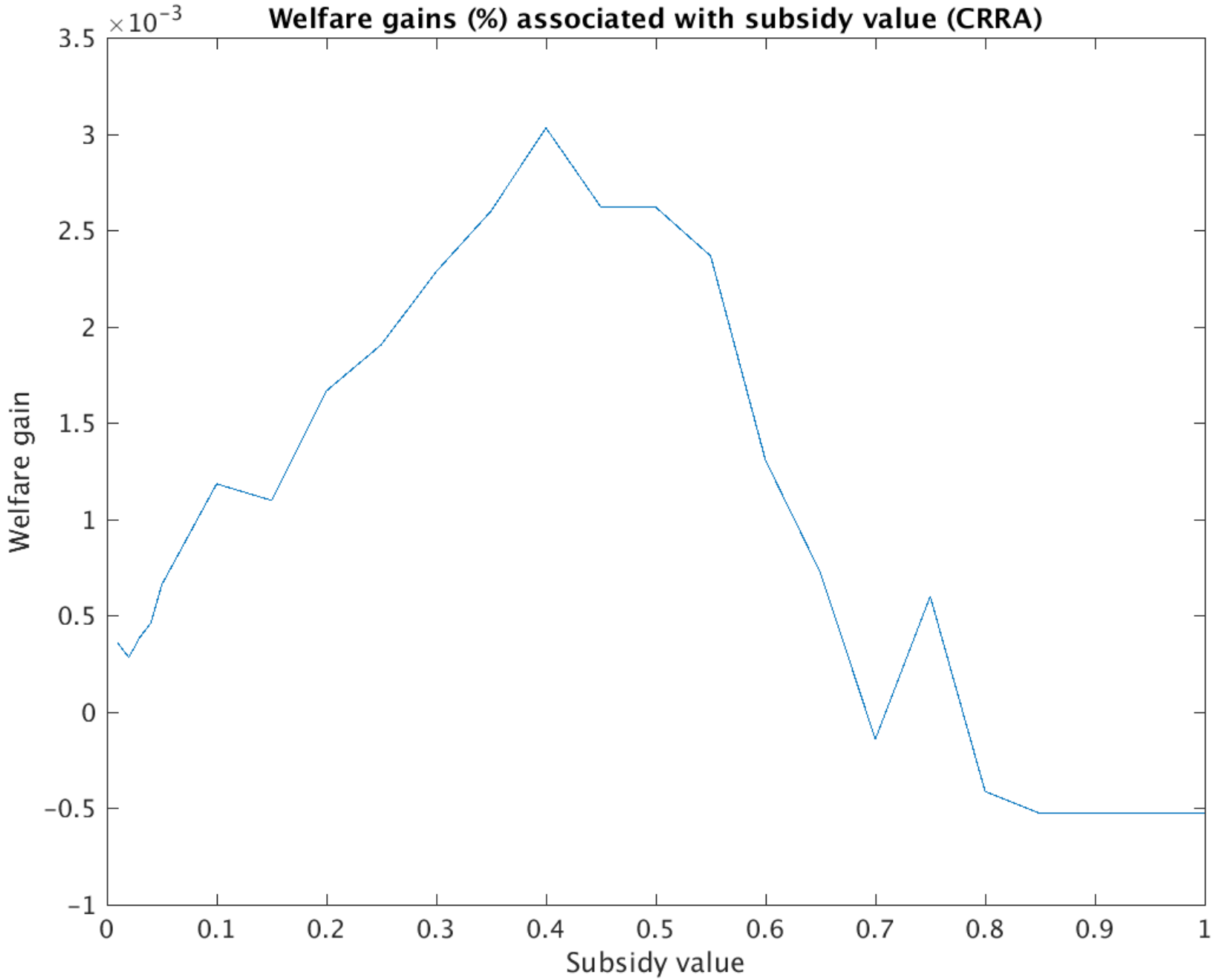
Welfare with Original Parameterization

- New technology subsidies were usually welfare diminishing.
- Proposed reason: "corner solution".
- Benefit of new technology (around 1.9) was too big compared with cost (weibull($\lambda = 1, \kappa = 2$)).
- Subsidies therefore would only very seldom have any positive effect at all.
- To test: increase $\lambda = 2$ without changing anything else.


Welfare gains (%) associated with subsidy value (CRRA)
×10^-3
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
Welfare gain
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Subsidy value

Welfare with Original Parameterization

- Welfare becomes a bell-shaped curve on subsidy.
- Curiously, optimal welfare brings the model back to the original parameterization.
- Even a 100% subsidy still has positive results. The reason is that there is a natural limit on new technologies, which is the probability that inventors come up with them.
- Also explains why the welfare effect is flat after a 70% subsidy.
- However, this is not always the case. If we increase the mode of the idea distribution by 1% and run the same simulation:

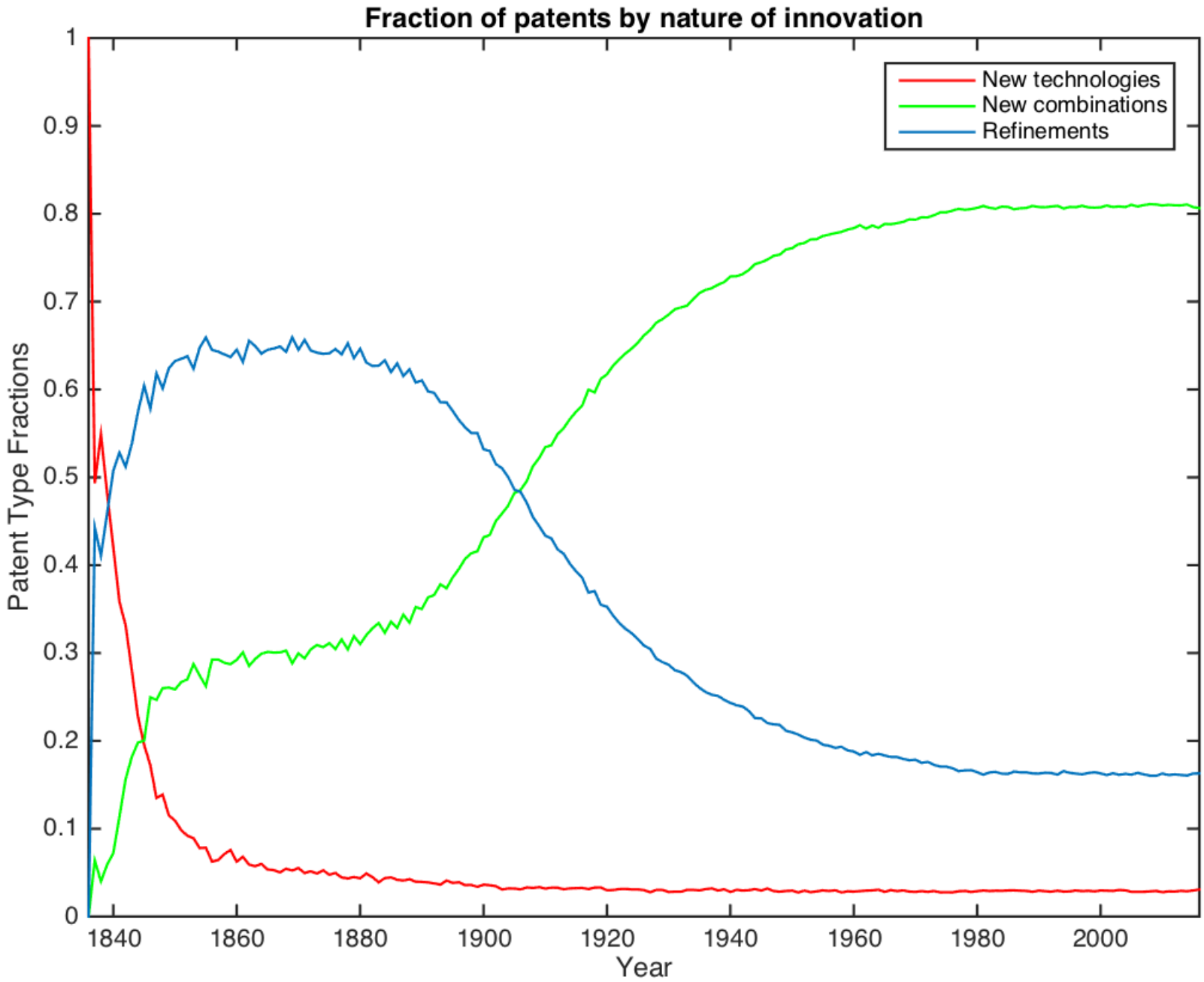

Welfare gains (%) associated with subsidy value (CRRA)
×10^-3
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
Welfare gain
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Subsidy value

Escape from Corner Solution

- Taking that into account, add an extra parameter to the model, ϕ.
- New ideas deistribution is now $g(\phi m, \tau)$ (before $\phi \equiv 1$).
- Recalibrate the model to fit patent fraction distributions over time (I did it crudely and by hand).
- Keep a higher cost, $\lambda = 2$ but with $\phi = 1.075$.
- Other values changed: $\xi = 5$, $\tau = 500$, $\eta^M = 0.1$.

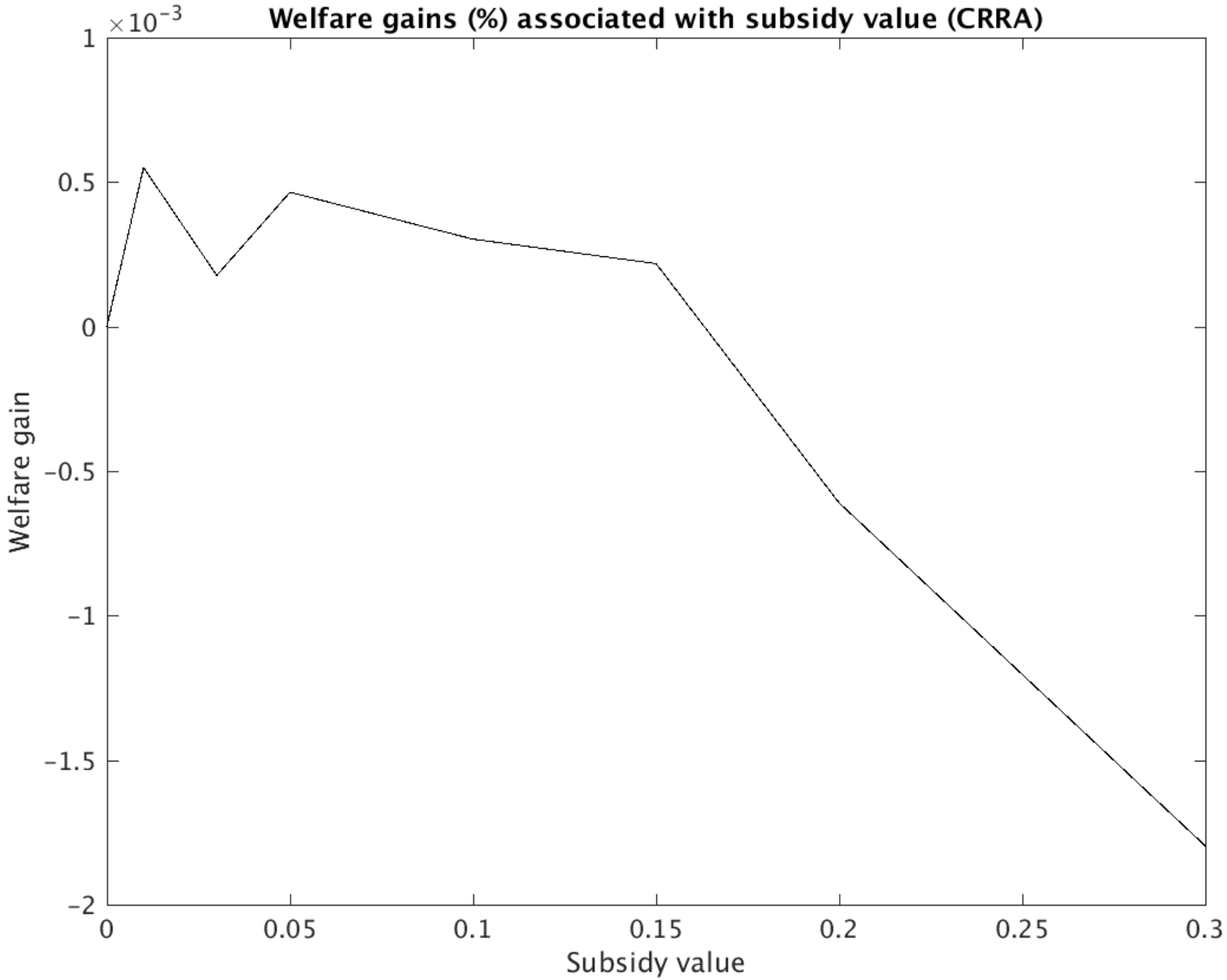
Moment Matching

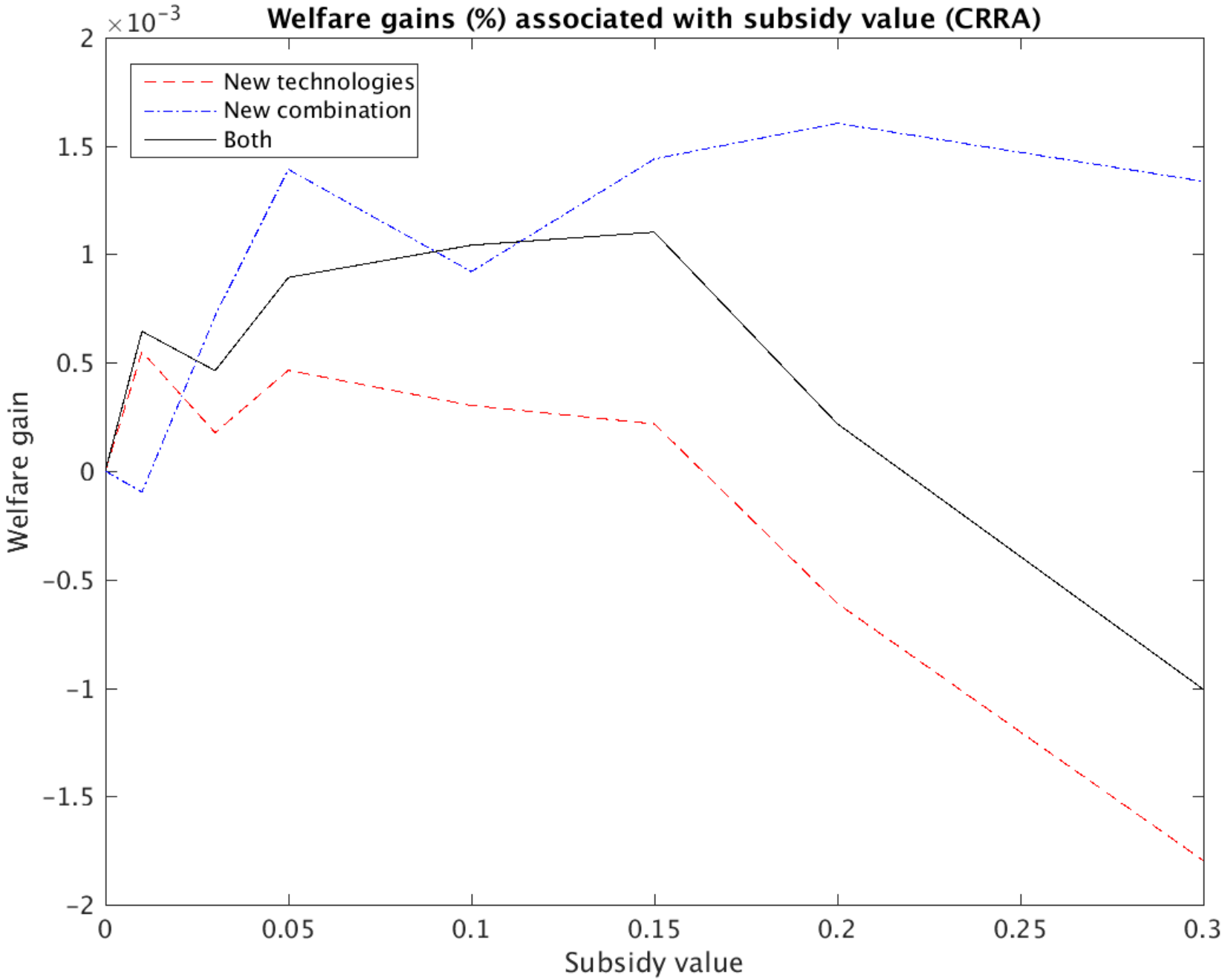
	Data	**Model**
new tech 1850	0.4	0.10921
new comb 1850	0.25	0.25847
reuse 1850	0.35	0.63232
new tech 1900	0.03	0.036378
new comb 1900	0.45	0.43172
reuse 1900	0.52	0.5319
new tech 1950	0.02	0.029526
new comb 1950	0.75	0.76079
reuse 1950	0.33	0.20968
new tech 2000	0.01	0.0297
new comb 2000	0.8	0.80735
reuse 2000	0.19	0.16295
reuse peak	0.55	0.65927


Fraction of patents by nature of innovation
New technologies
New combinations
Refinements
Patent Type Fractions
Year
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1840
1860
1880
1900
1920
1940
1960
1980
2000

Results from Optimal Subsidy

- Optimal subsidy has a inverted-U shape, but with a much lower peak.
- Also try subsidy for new combinations (alone) and all ideas.
- New combinations subsidy does a much better job to increase welfare: it still has the externality of getting product lines to become hot, but it is a much higher fraction of patents, with a larger potential for influencing the mean quality of goods.


Welfare gains (%) associated with subsidy value (CRRA)
×10^-3
1
0.5
0
-0.5
-1
-1.5
-2
Welfare gain
0
0.05
0.1
0.15
0.2
0.25
0.3
Subsidy value


Welfare gains (%) associated with subsidy value (CRRA)
×10^-3
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1.5
1
0.5
0
−0.5
−1
−1.5
−2
Welfare gain
0
0.05
0.1
0.15
0.2
0.25
0.3
Subsidy value
New technologies
New combination
Both

Thoughts

- The fact that the new combination subsidy has better results than the new technologies subsidy is surprising; but it also makes sense.
- New combinations are the majority of patents, so a subsidy on new combinations would increase the quality of goods by much more than new technologies ever could (and mostly at the expense of reuses, I think).
- New combinations also have the same externality as new technologies, which is to make product lines hot.
- Interesting conclusion from model: even though it is getting harder and harder to create new technologies, and this could have bleak consequences for growth, the economic growth in the past 50 years or so has been driven by new combinations instead of new technologies.
- And the possibilities for new combinations only tend to increase, while the chance of creating new technologies only tends to decrease.