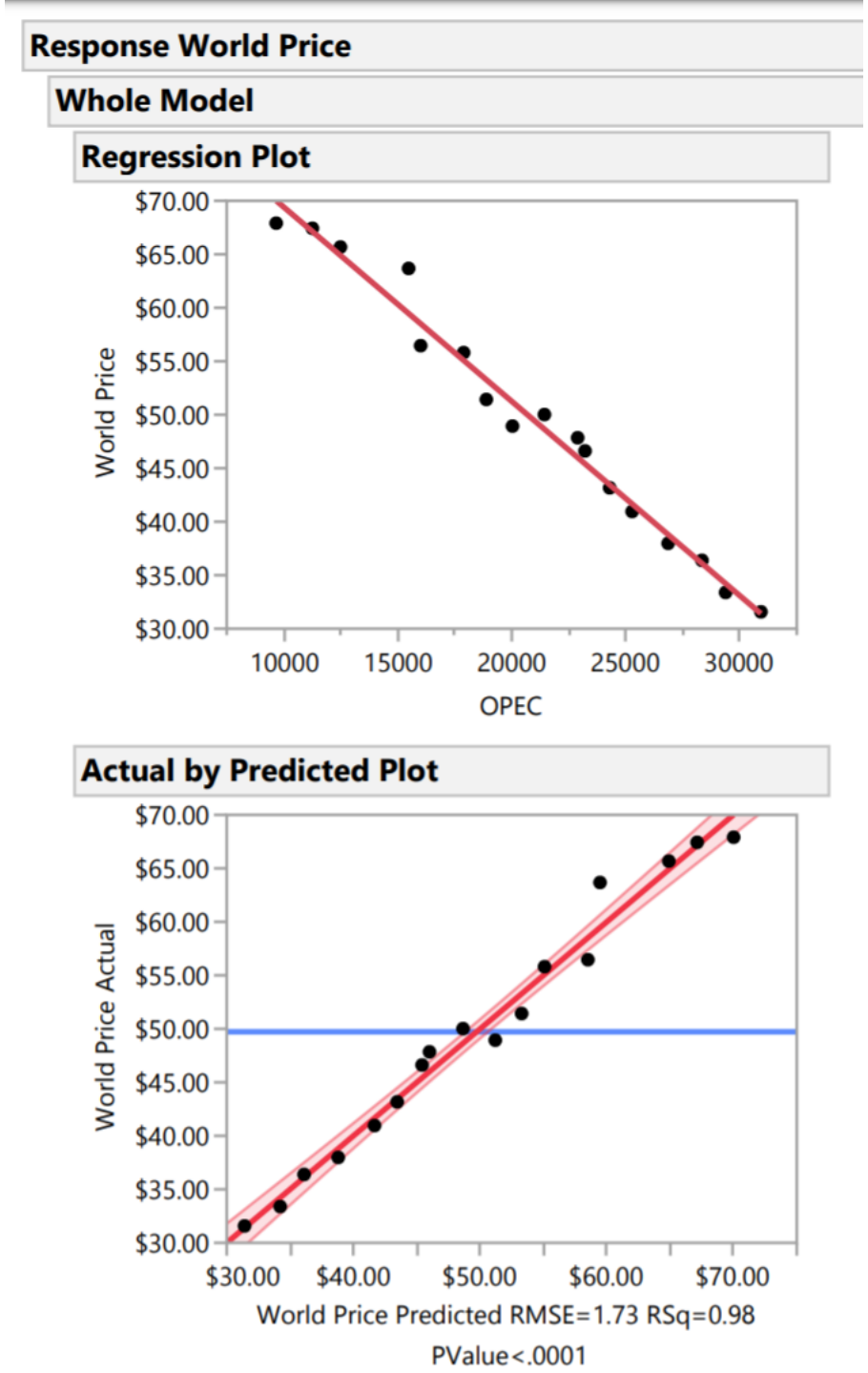
Pricing the Countries

Demand curve

- I fit a linear regression model to investigate the standard error of the slope and intercept estimates.



Demand curve

- The estimated demand curve is $P = 87.57248 - 0.0018161 \cdot Q$
- The residual has standard deviation = $1.675058
- That is equivalent to 922 (thousand barrels) of production

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	87.57248	1.464014	59.82	<.0001*
OPEC	-0.001816	6.73e-5	-26.98	<.0001*

- From here on, assume

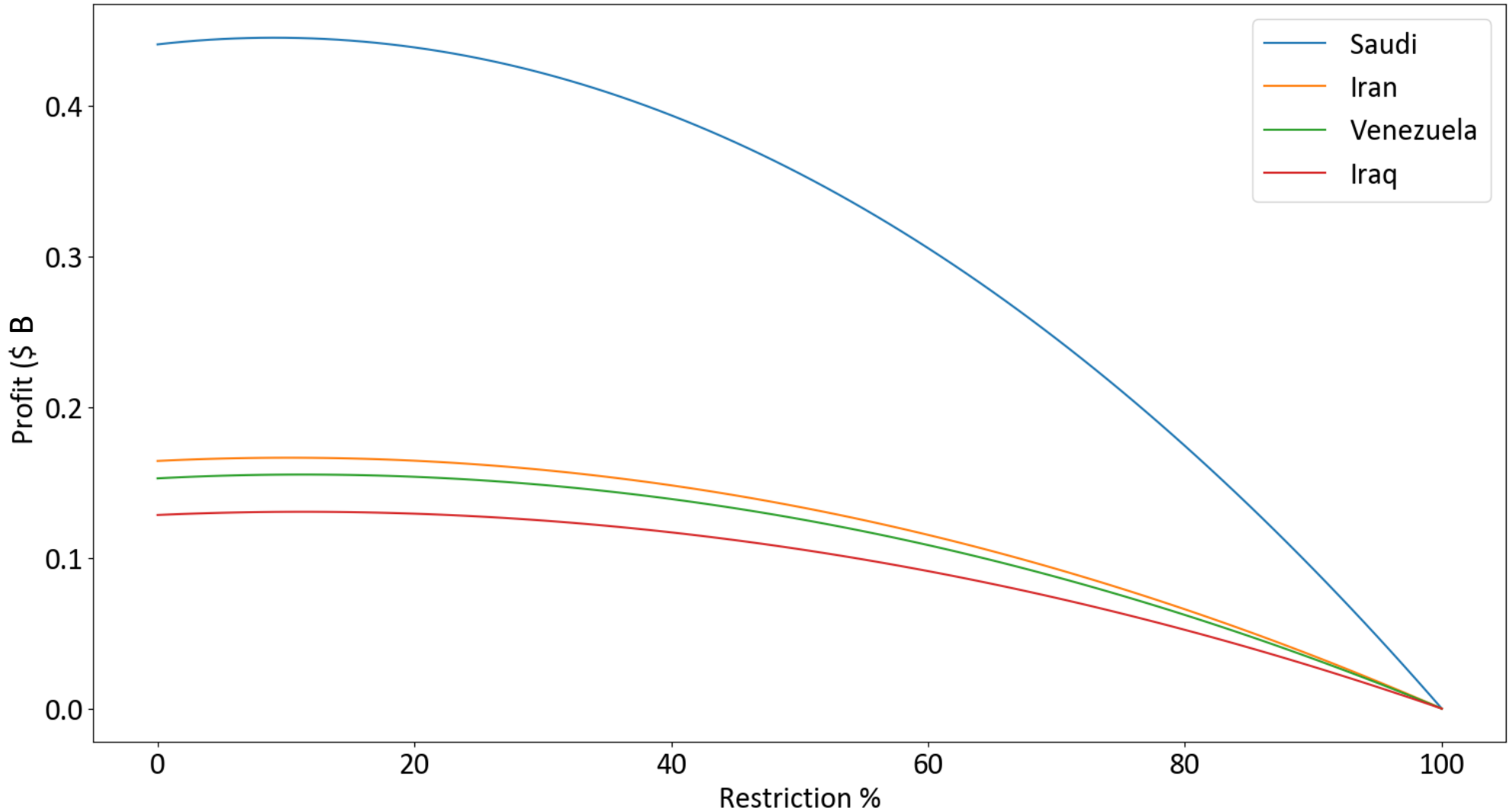
$$P = 87.57248 - 0.0018161 \cdot Q$$

Be selfish = maximize production

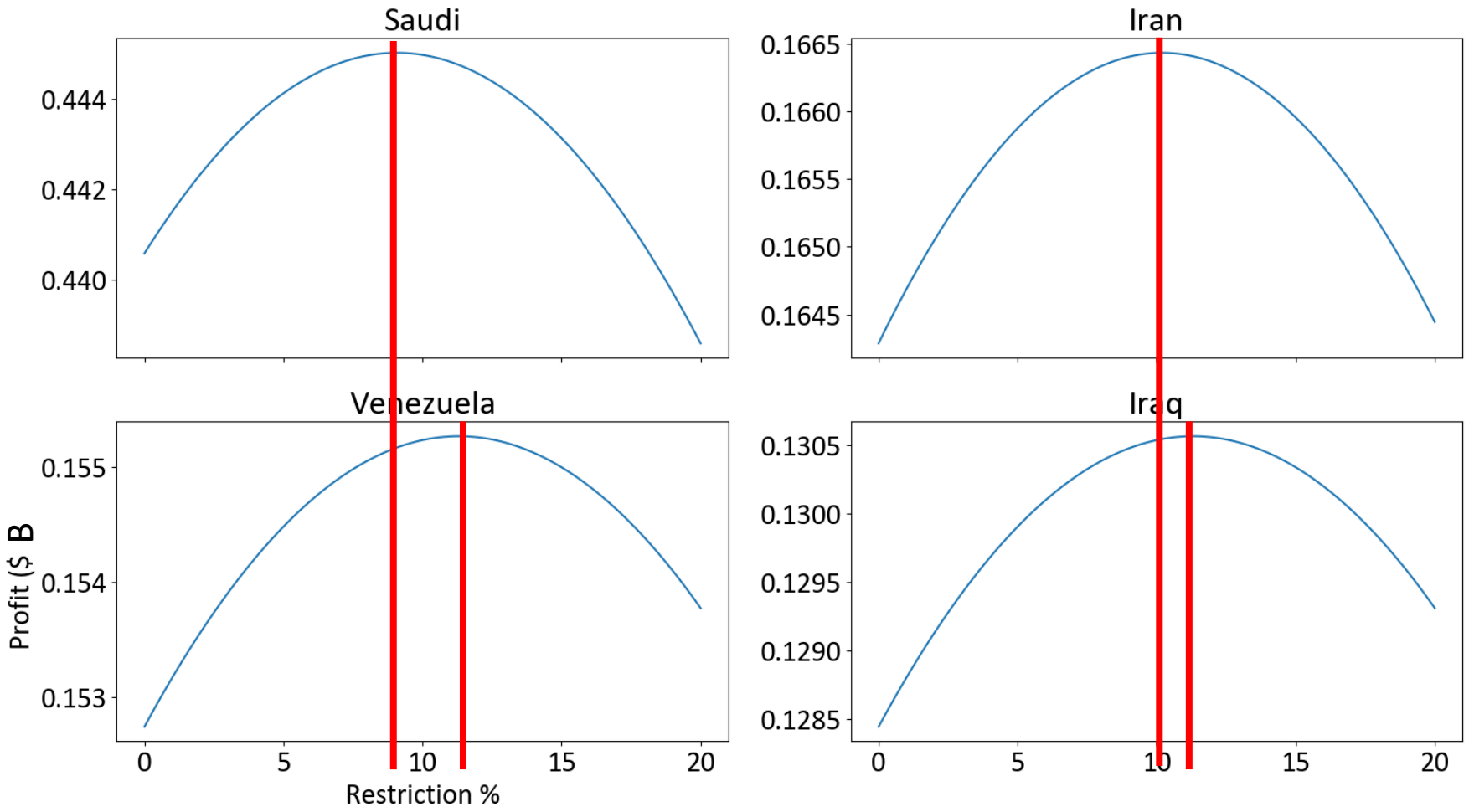
- When all other nations output is fixed, the optimal production is max.
- On the right is a simulation assuming all other nations produces max (extreme case). x is production percentage. Observe that optimal $x \gg 1$.

```
Saudi
     fun: -471227.800528619
    nfev: 6
     nit: 5
 success: True
       x: 1.342345548152635
Iran
     fun: -279610.572528619
    nfev: 5
     nit: 4
 success: True
       x: 2.697423169093 83
Venezuela
     fun: -275121.84652861906
    nfev: 5
     nit: 4
 success: True
       x: 2.797306040416 2755
Iraq
     fun: -259697.341278619
    nfev: 5
     nit: 4
 success: True
       x: 3.231931459679 4726
```

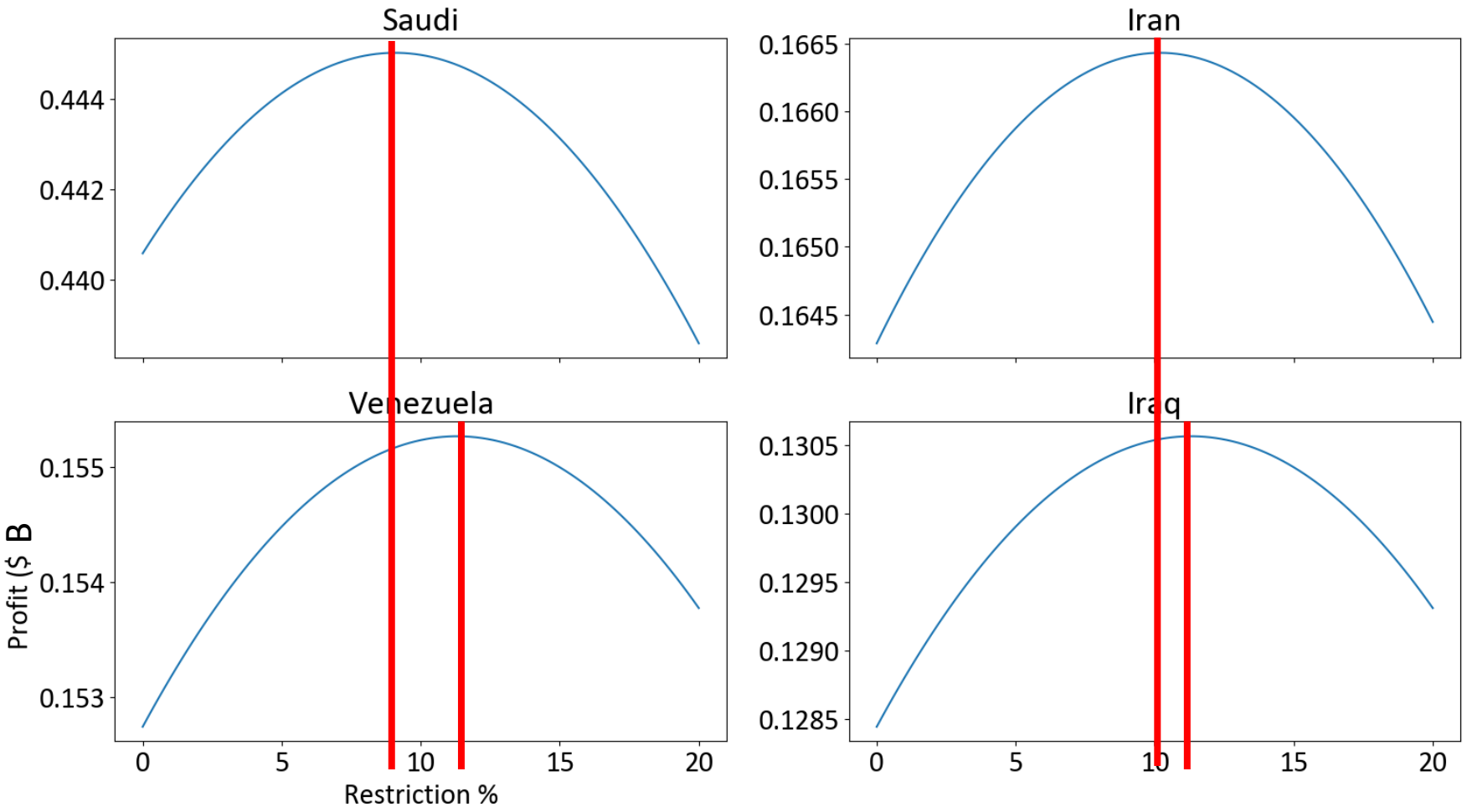
Be nice: assuming every nation restricts by equal percentage



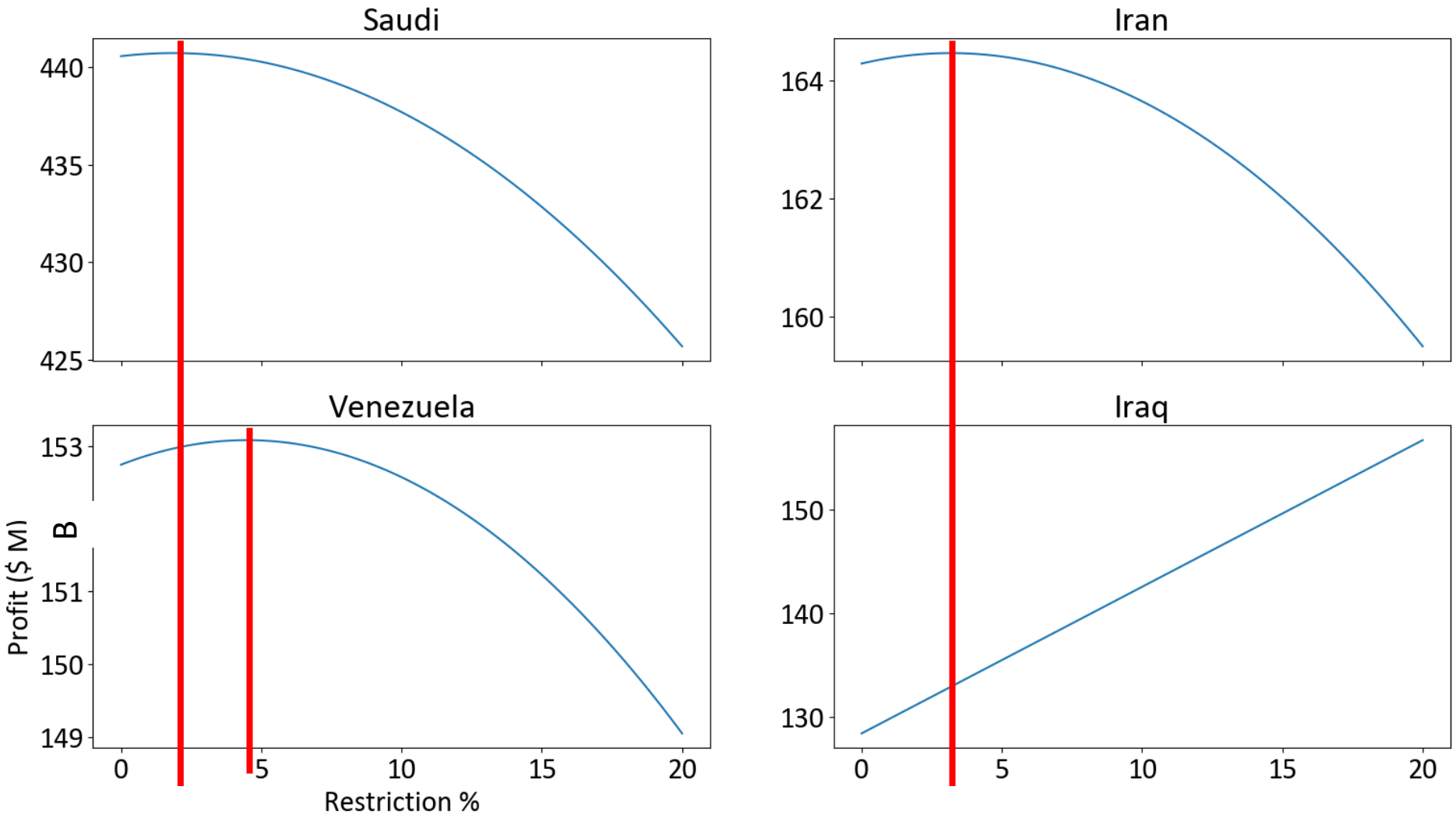
Be nice: assuming every nation restricts by equal percentage



Restrict 9.07633%? (Saudi max profit)



Restrict 1.86597% in market B & C



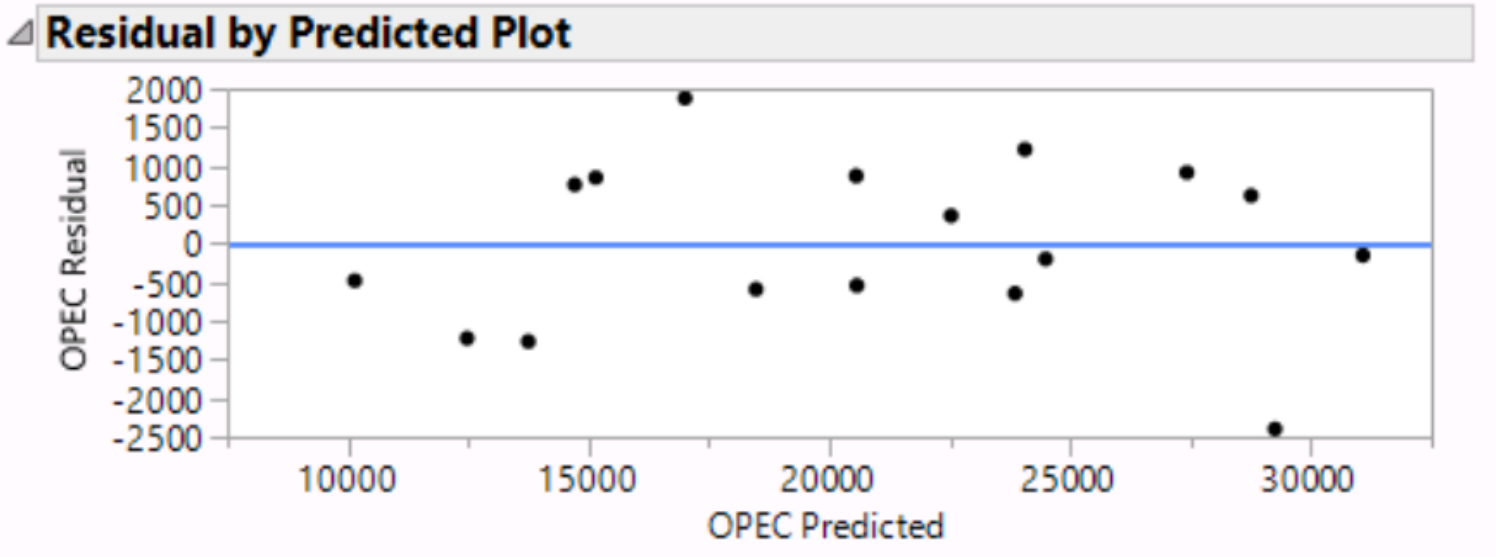
Conclusion

- Nations will restrict by x%, where
- $0 \leq x \leq 9.07633$ in market A
- $0 \leq x \leq 1.86597$ in market B & C

- Next topic

Backing out OPEC production

- Use world output to estimate OPEC output.
- Standard deviation = 1079 (thousand barrels)
- For reference: Iraq 9% restriction = 333. Impossible to convict!
- Saudi 9% restriction = 1080. Almost impossible to convict!



- Next topic

After auction, everyone is supposed to be equal

- Proof by contradiction.
- Assume the correct valuation of nations are $x_1, x_2, \ldots x_{10}$.
- Assume the ten teams buy the nations at the correct valuations and are unequal.
- Trivially, say team A bought nation 1 for $\$x_1$ and has a winning probability higher than the rest of the teams.
- If so, other teams would rather have bought country 1 for $\$x_1 + 1$.
- Therefore, the assumption is invalid.
- QED.

- Next topic

Worst country = $100M

- Imagine we go into the auction, and do not bid.
- The rest of the teams got 9 countries.
- The 10^{th} country left for us, is, in the worst case, the worst country.
- We can buy it for $100M (initial bidding price).
- Therefore, the valuation of the worst country cannot be higher than$100M.

Worst country = $100M

- As a consequence, after we calculate the expected overall profit for each nation, we should offset these numbers until the worst nation is $100M.

- For example:
  220M 210M 240M 300M
  should become
  110M 100M 130M 190M.

- Next topic

Expected profit under various scenarios

- Scenario A: *war of all against all*
  everyone maximizes.
- Scenario B: *nice cooperation*
  everyone starts restricting by 9%, but maximizes from turn 11.
- Scenario C: *nobody notices me*
  I always maximizes, while everyone else always restricts 9%.

Expected profit under various scenarios

Saudi	Iran	Venezuela	Iraq
Scenario A: *war of all against all*			
5177	1930	1795	1509
Scenario B: *nice cooperation*			
5221	1952	1819	1530
Scenario B: *nice cooperation* in market B & C where Iraq is non-strategic			
5178	1932	1797	/
Scenario C: *nobody notices me* (UNREALISTIC)			
5502	2128	1985	1675
(Unit:$ M, sum over 13 turns, w/ 12th 13th diminished)			

Nation valuation under various scenarios

Saudi	**Iran**	**Venezuela**	**Iraq**
Scenario A: *war of all against all*			
3768	521	386	100
Scenario B: *nice cooperation*			
3791	522	389	100
Scenario B: *nice cooperation* in market B & C where Iraq is non-strategic			
3748	502	367	/

- Next topic

Retaliation effectiveness

- When nation 1 offends, nation 2 3 4 retaliates nation 1.
- How many turns to they have to promise to retaliate so that nation 1 would not offend?

Retaliation effectiveness

- When nation 1 offends, nation 2 3 4 retaliates nation 1.
- How many turns to they have to promise to retaliate so that nation 1 would not offend?
- In market A, if Saudi offends, Saudi gains 20.69 M
  If the rest three retaliates, Saudi loses 25.12 M
- So retaliation works, and 1 period retaliation is enough.

Recap on the assumptions

- All nations restrict at equal percentage.
- The underlying demand function is as regressed.

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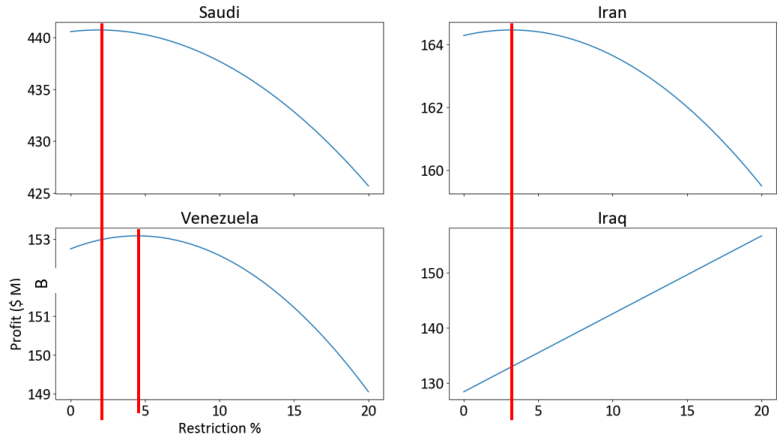
Future work:

- Assumption 1 should be dropped in market B & C, since the rest of the two countries may want to restrict more.



Footnote

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- It seems market B and C might as well always max out.
- Only market A has game going on.

- Thank you for viewing