Principles of Economics

Distorting and Undistorting Competitive Markets

Externalities: What Would a Planner Do?

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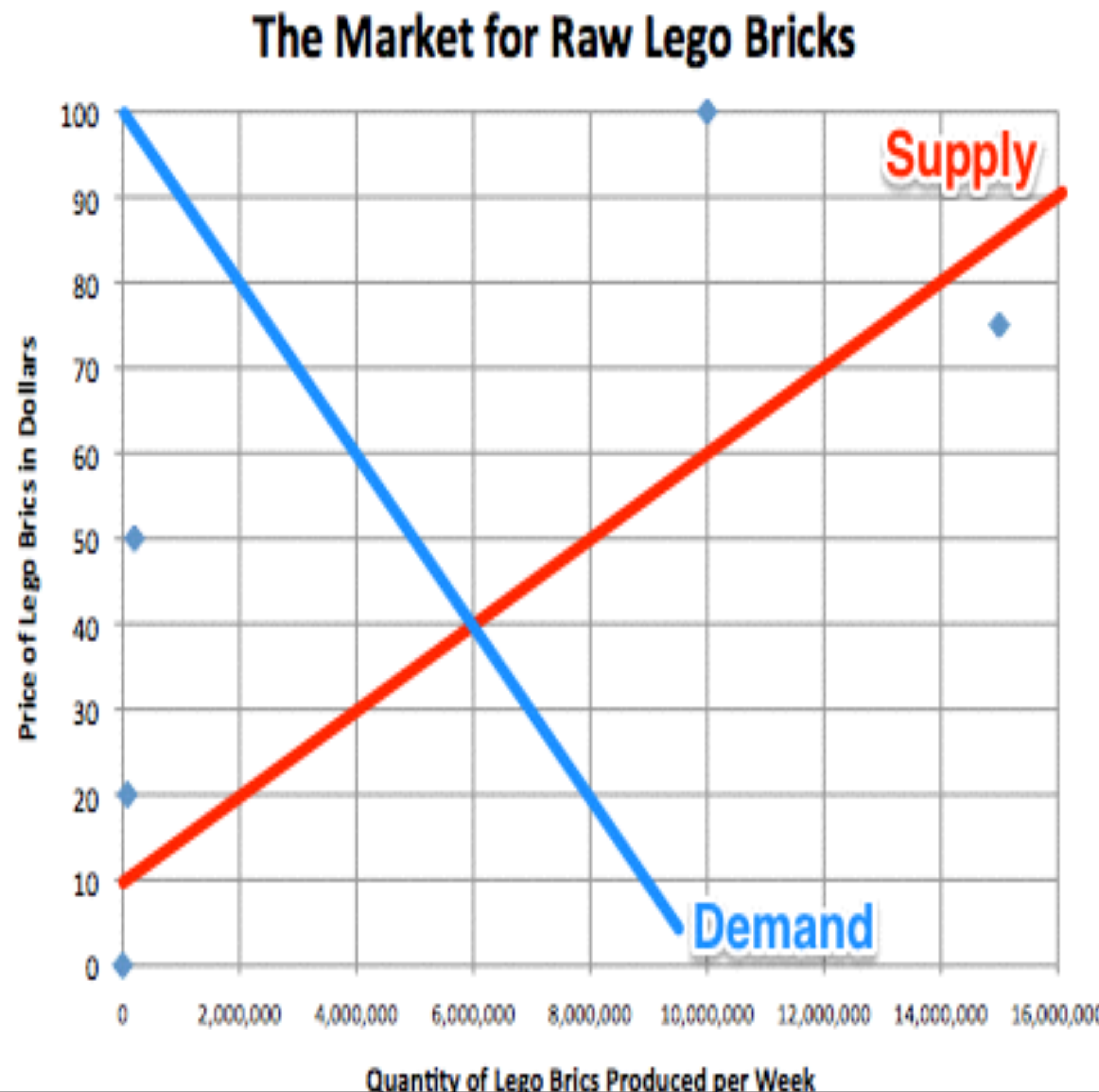
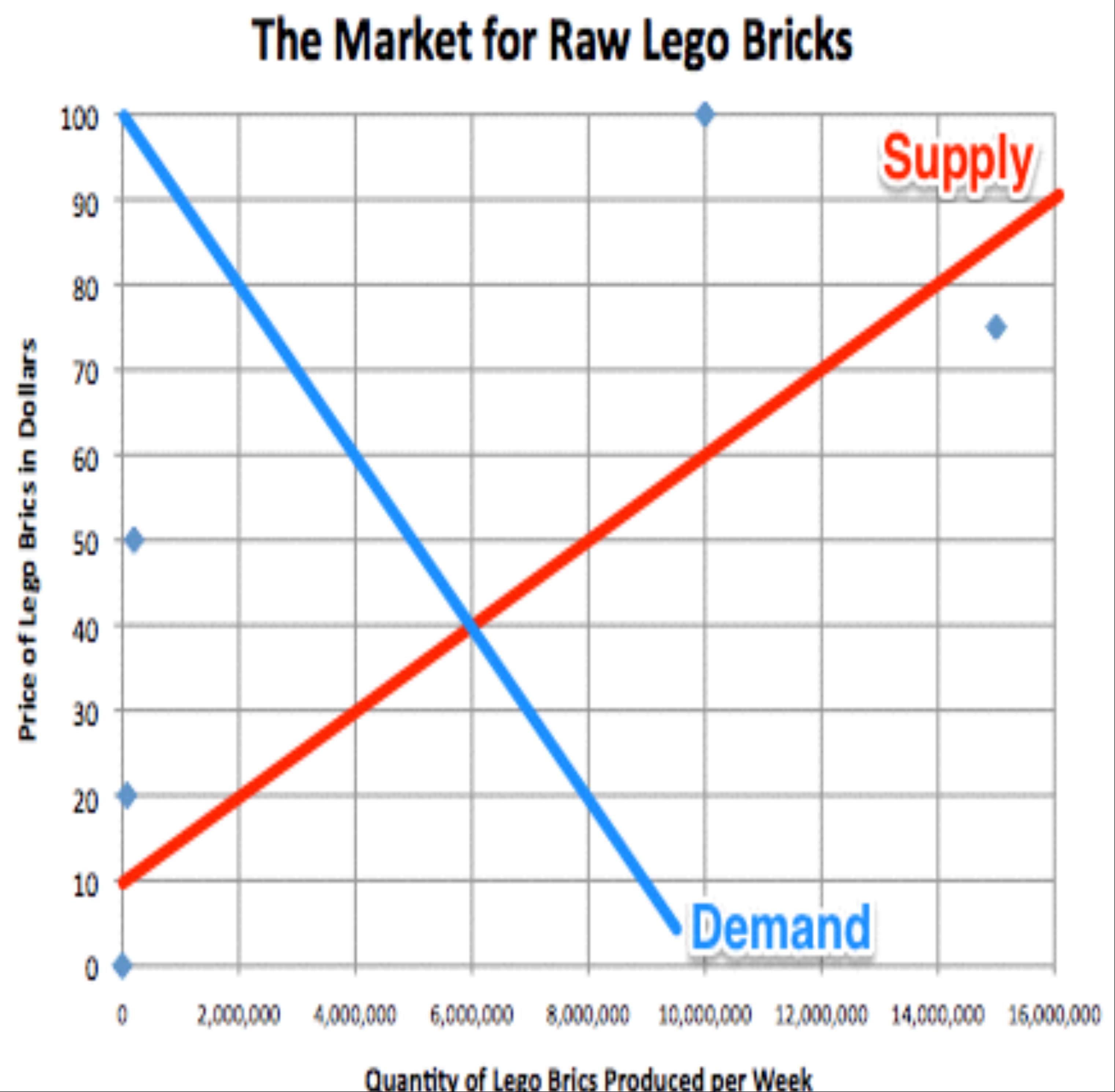
Our Market for Brics

- Supply:
  - $P_s=10+0.000005Q$
- Demand:
  - $P_d=100-0.00001Q$



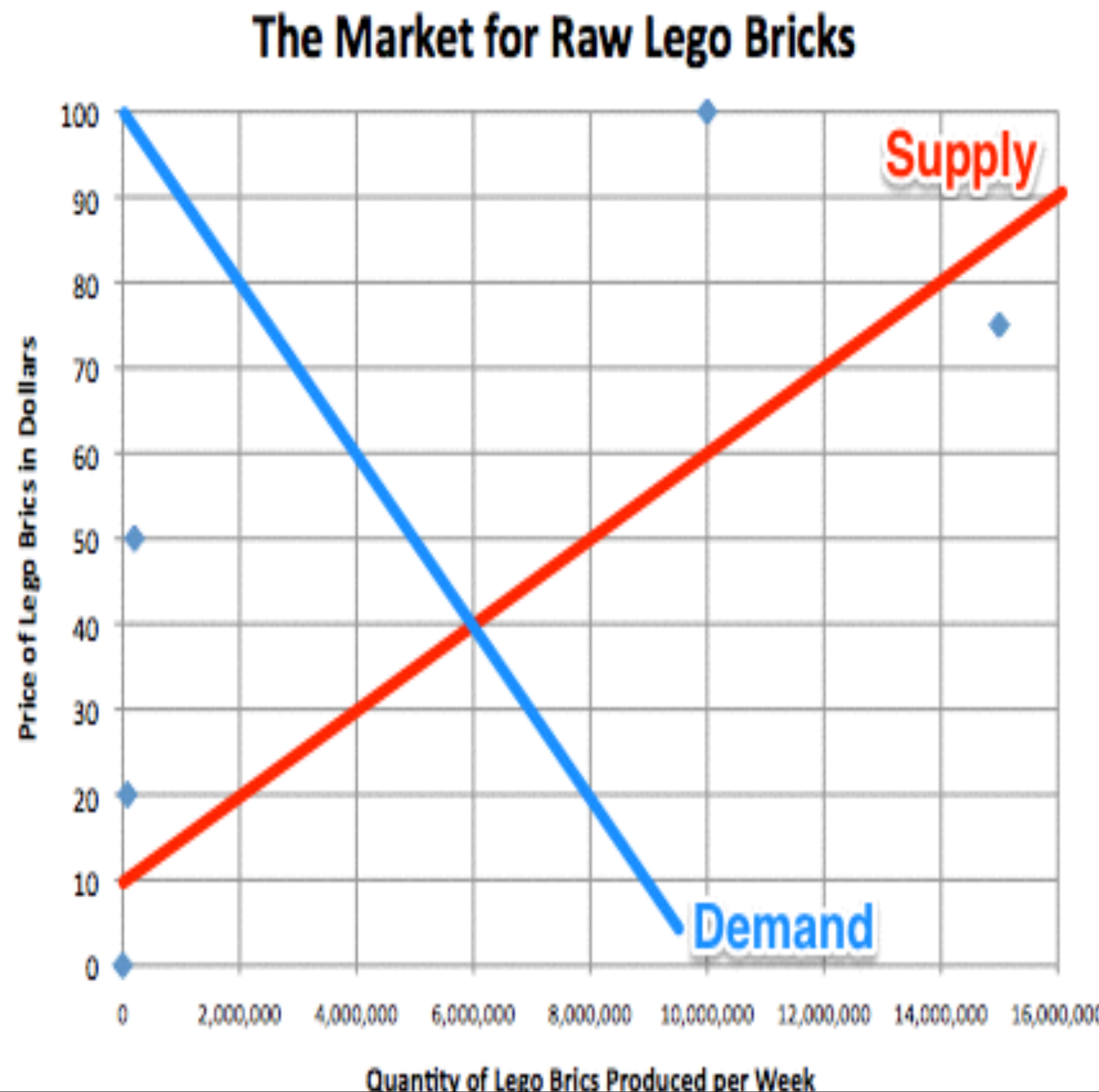
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics

- Seek to figure out what is going on…
- First: how valuable are the brics produced?
- Demand:
  - $P_d = 100 - 0.00001Q$
- Suppose we choose to produce an amount Q, and sell it
- What will the average valuation be?



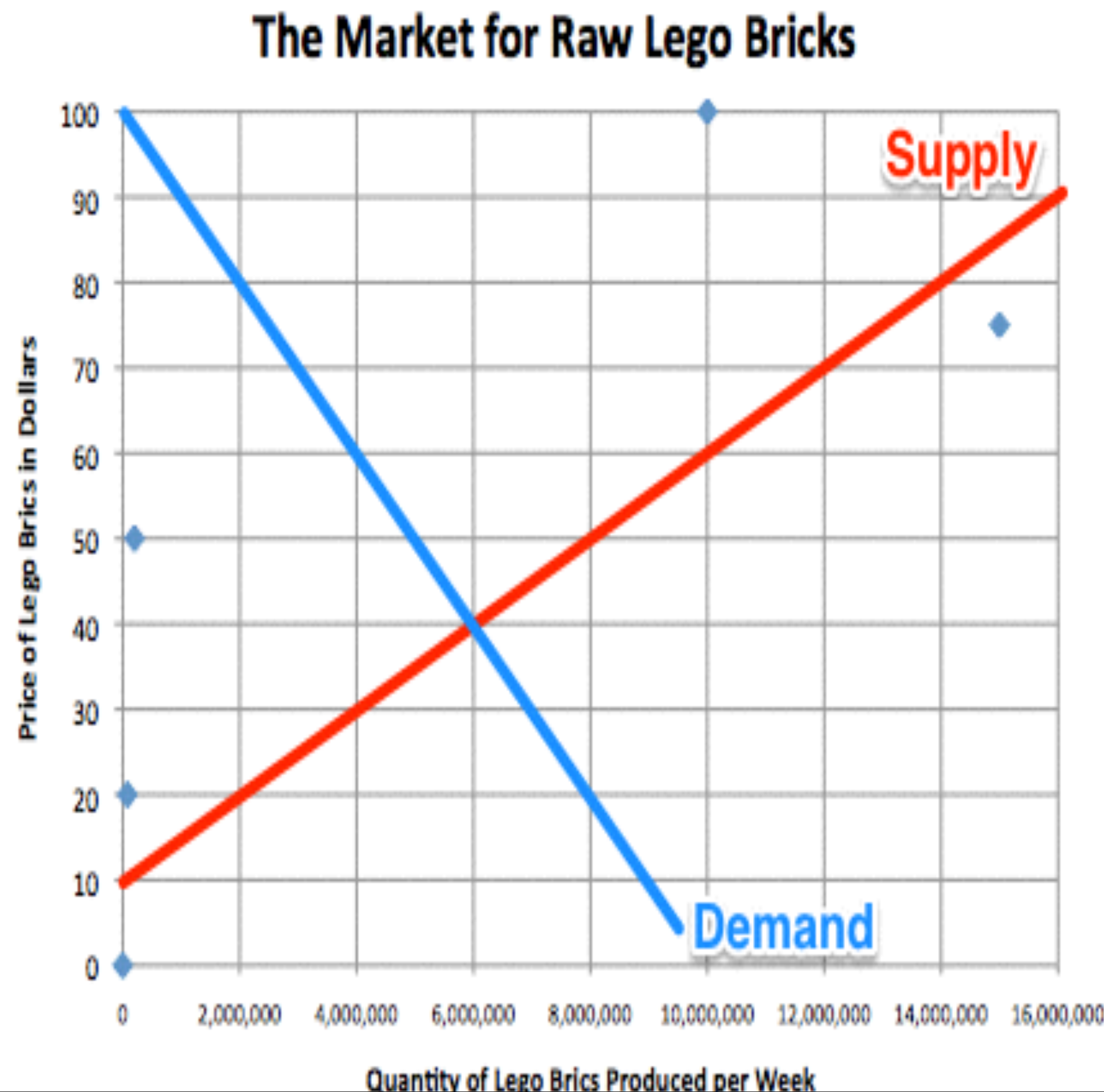
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics II

- Demand:
  - P_d=100-0.00001Q
- Suppose we choose to produce an amount Q, and sell it
- What will the average valuation be?
  - AV = (100 + P_d)/2
- What will the total value be?
  - TV = Q x (100 + P_d)/2



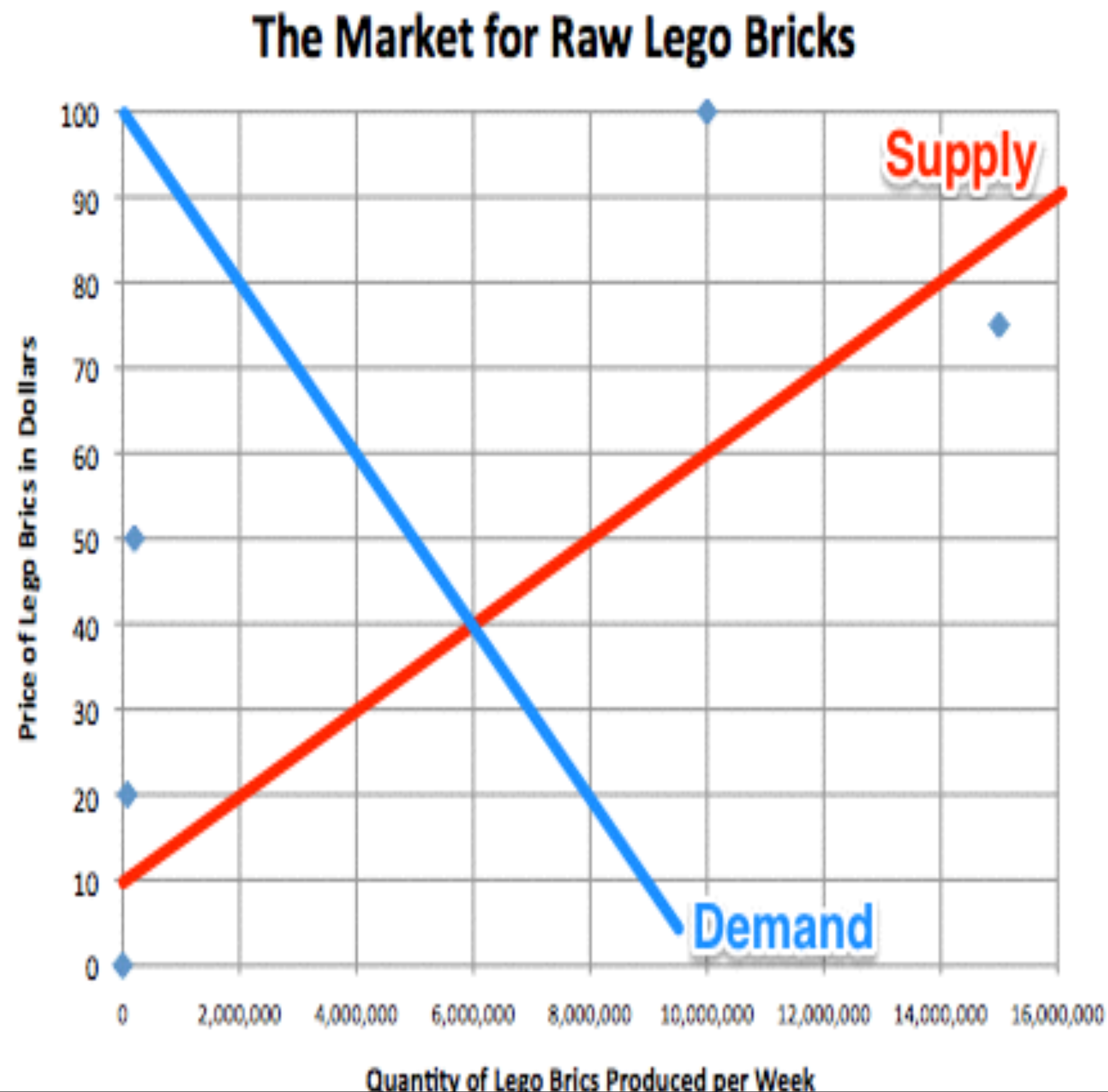
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics III

- Demand:
  - $P_d = 100 - 0.00001Q$
- Total Value:
  - $TV = Q \times (100 + P_d)/2$
- Supply:
  - $P_s = 10 + 0.000005Q$
- Average Cost:
  - $AC = (10 + P_s)/2$



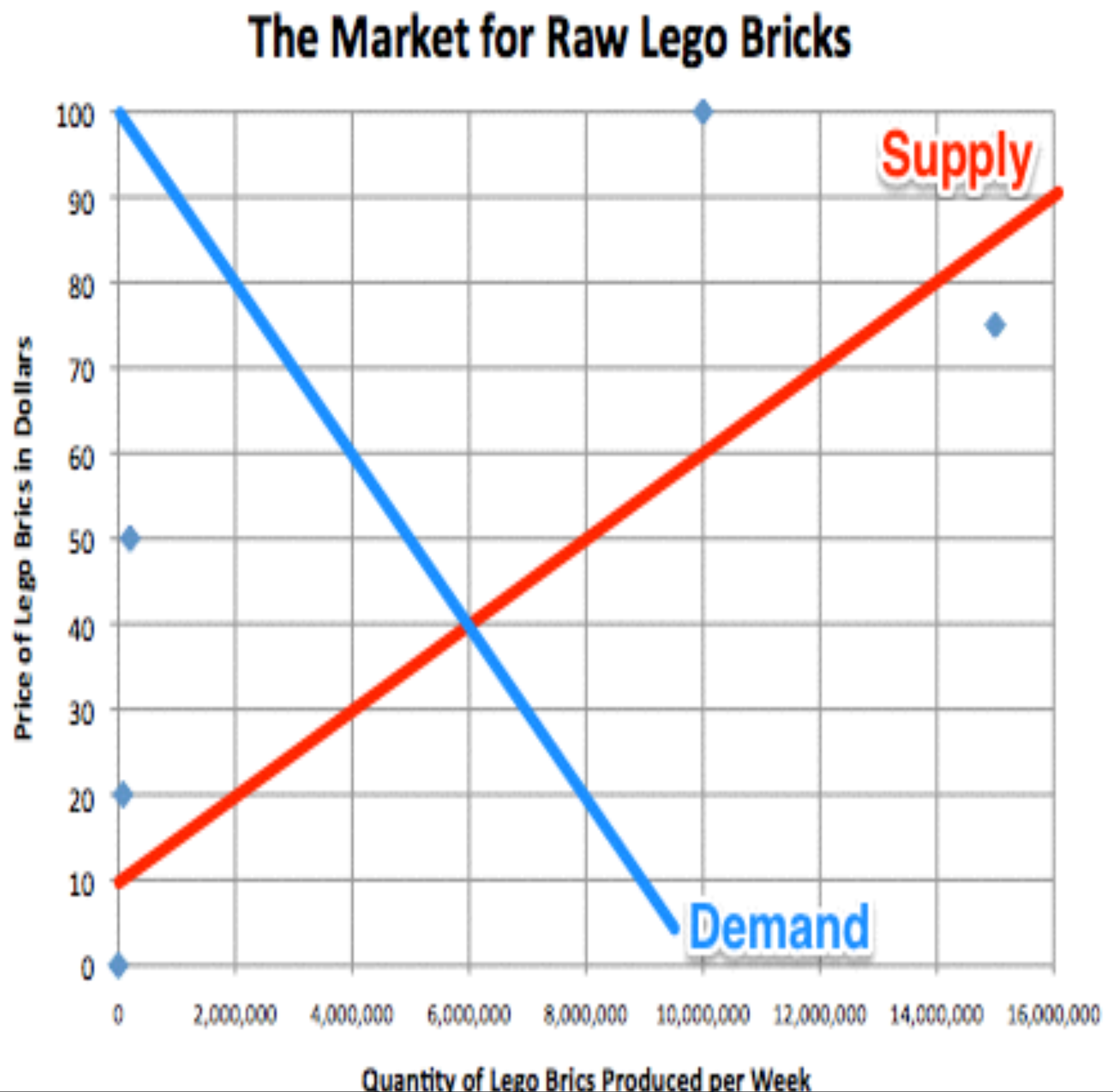
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics IV

- Demand:
  - $P_d = 100 - 0.00001Q$
- Total Value:
  - $TV = Q \times (100 + P_d)/2$
- Supply:
  - $P_s = 10 + 0.000005Q$
- Average Cost:
  - $AC = (10 + P_s)/2$
- Total Cost:
  - $TC = Q \times (10 + P_s)/2$



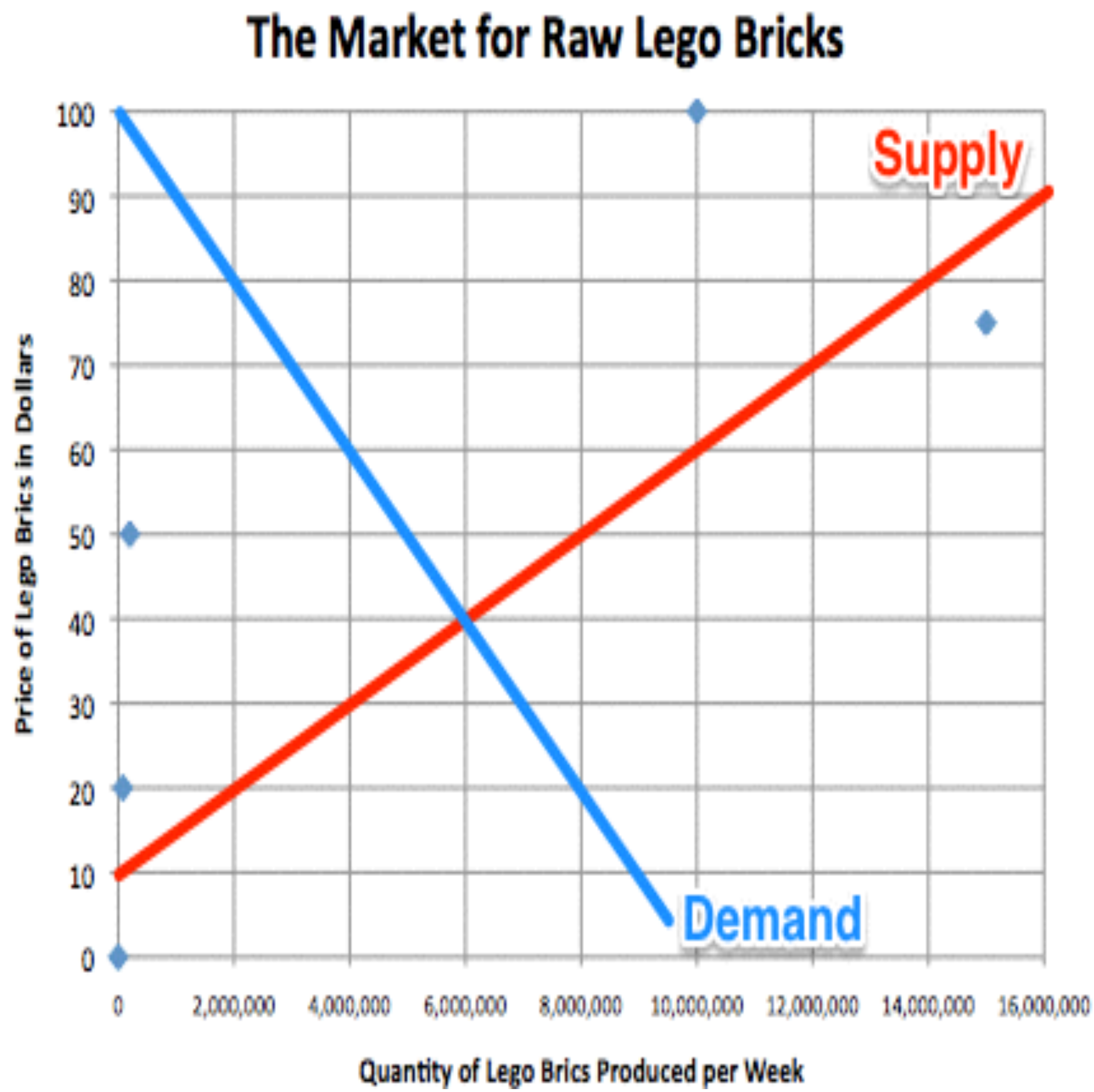
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics V

- Demand:
  - $P_d=100-0.00001Q$
- Total Value:
  - $TV = Q \times (100+P_d)/2$
- Supply:
  - $P_s=10+0.000005Q$
- Total Cost:
  - $TC= Q \times (10+P_s)/2$
- Total Surplus:
  - $TS = TV - TC$



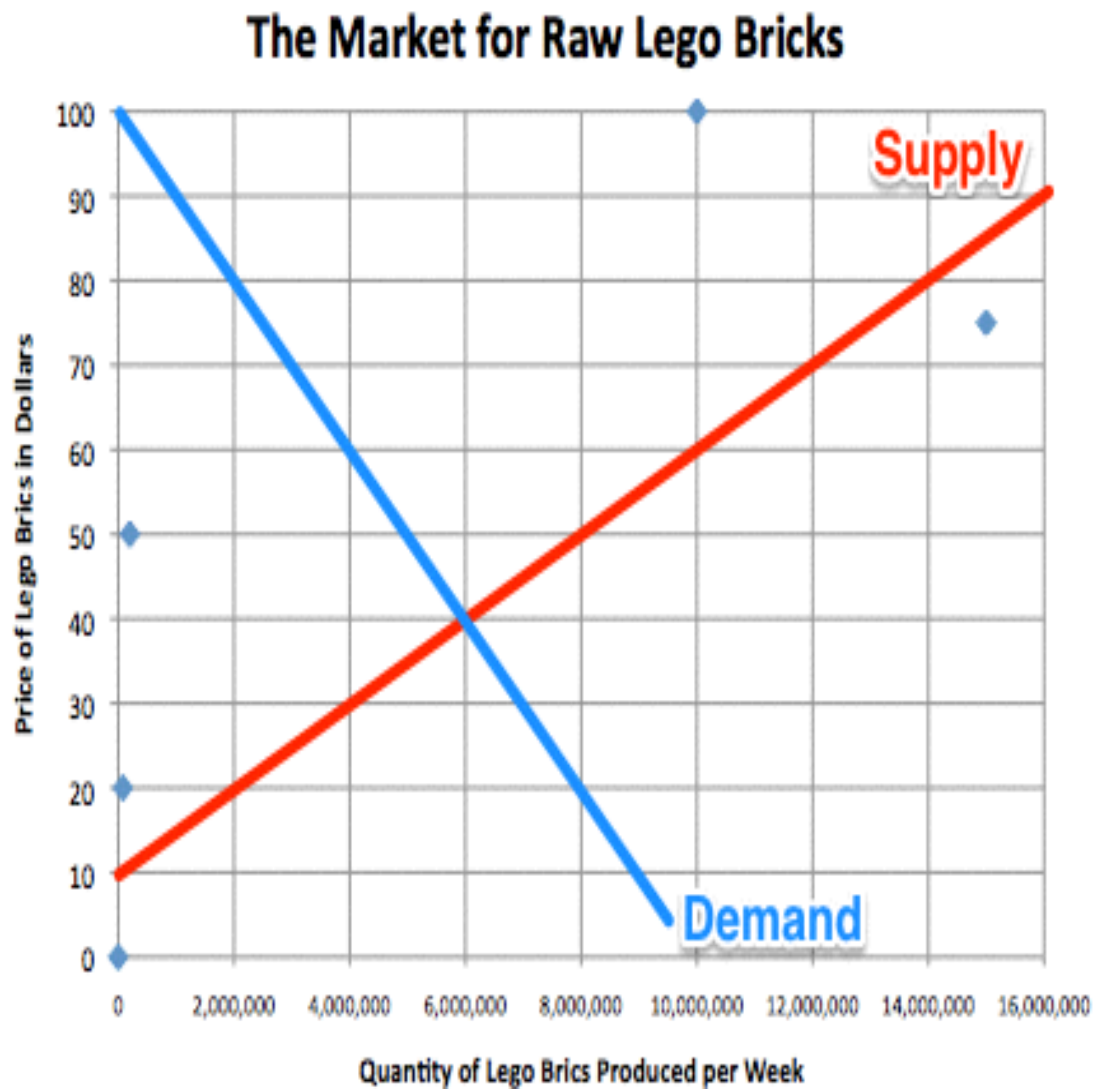
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics VI

- P_d=100-0.00001Q
- P_s=10+0.000005Q
- TV = Q x (100+P_d)/2
- Total Cost:
  - TC= Q x (10+P_s)/2
- Total Surplus:
  - TS = TV - TC
  - TS = Q x (100+P_d)/2 - TC



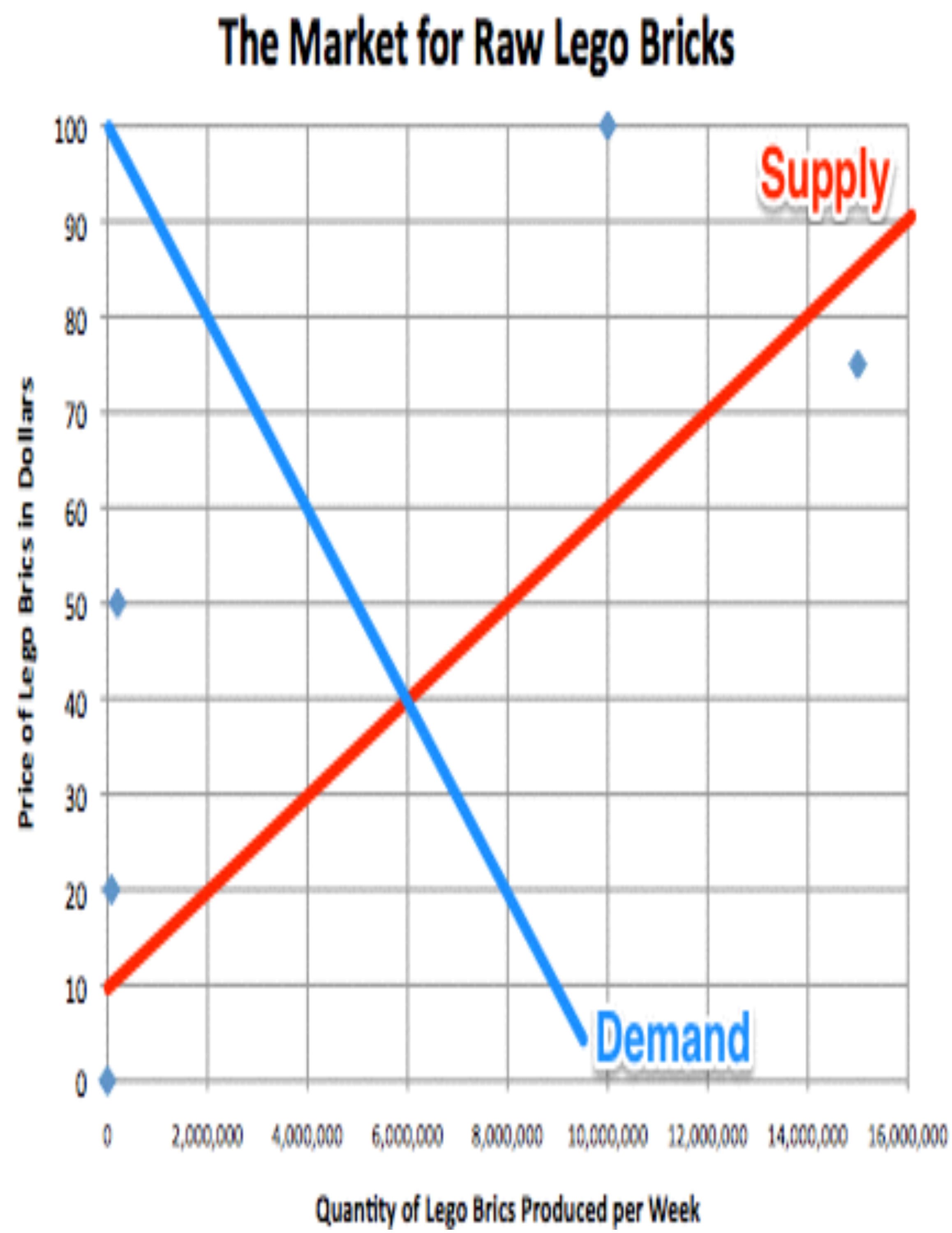
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics VII

- P_d=100-0.00001Q
- P_s=10+0.000005Q
- Total Surplus:
  - TS = TV - TC
  - TS = Q x (100+P_d)/2 - Q x (10+P_s)/2
  - TS= Q(45+(P_d-P_s)/2)



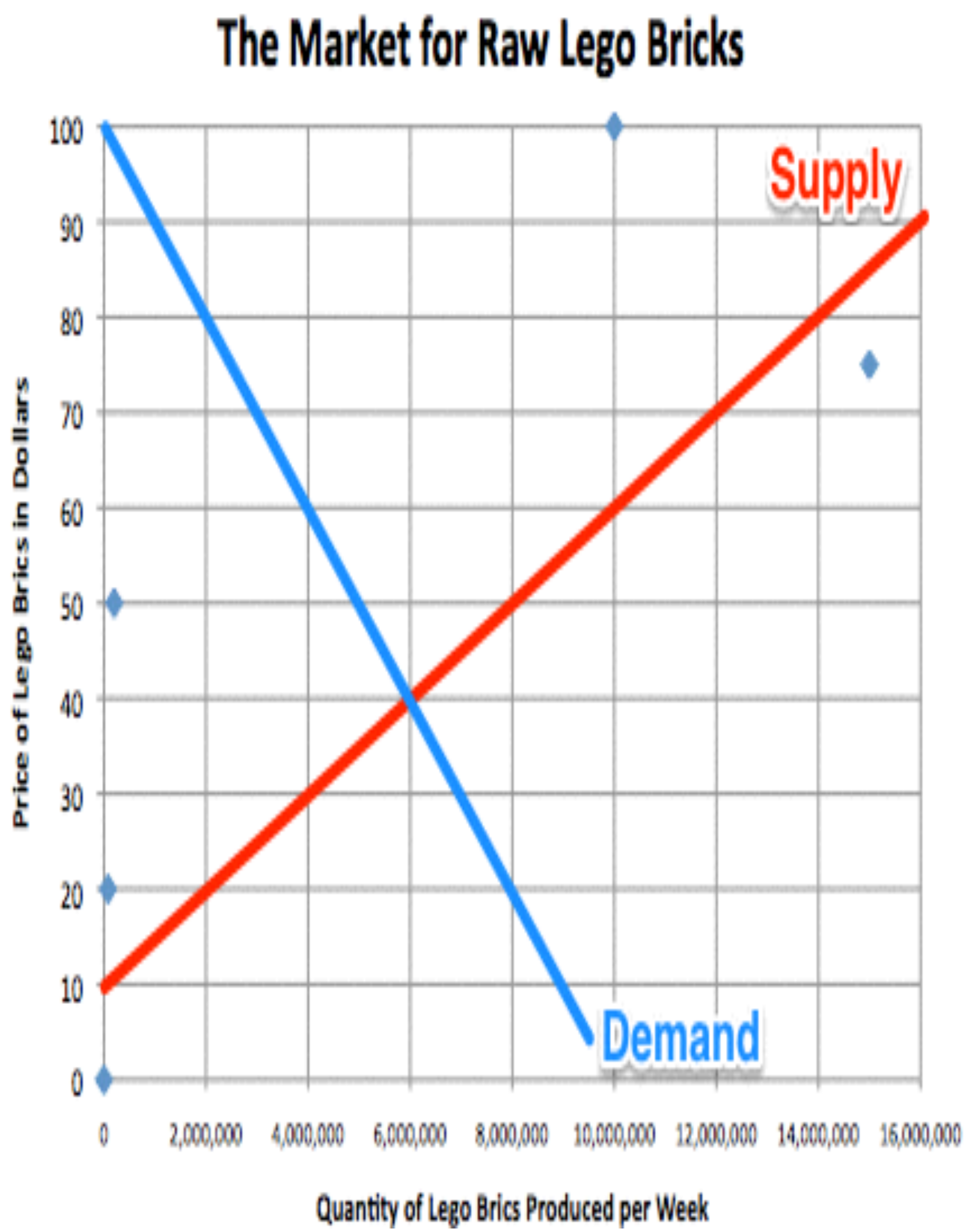
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics VIII

- P_d=100-0.00001Q
- P_s=10+0.000005Q
- Total Surplus:
  - TS = Q(45+(P_d-P_s)/2)
  - TS=Q(45+(100-0.00001Q-P_s)/2)
  - TS=Q(45+(100-0.00001Q-(10+0.000005Q))/2)



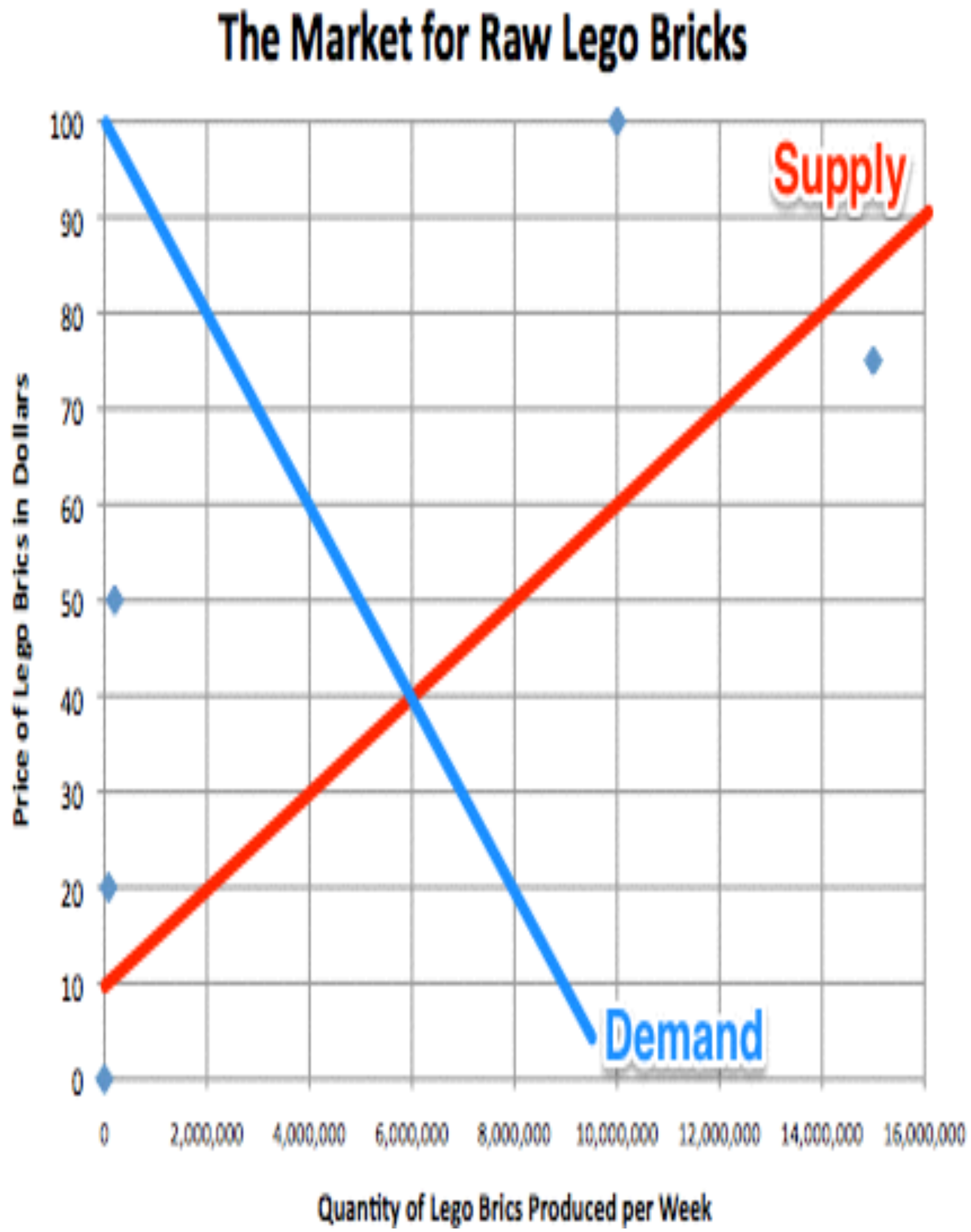
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics IX

- Total Surplus:
  - $TS = Q(45+(P_d-P_s)/2)$
  - $TS = Q \times (45 + (100-0.00001Q-(10+0.000005Q))/2)$
  - $TS = Q(90-0.0000075Q)$



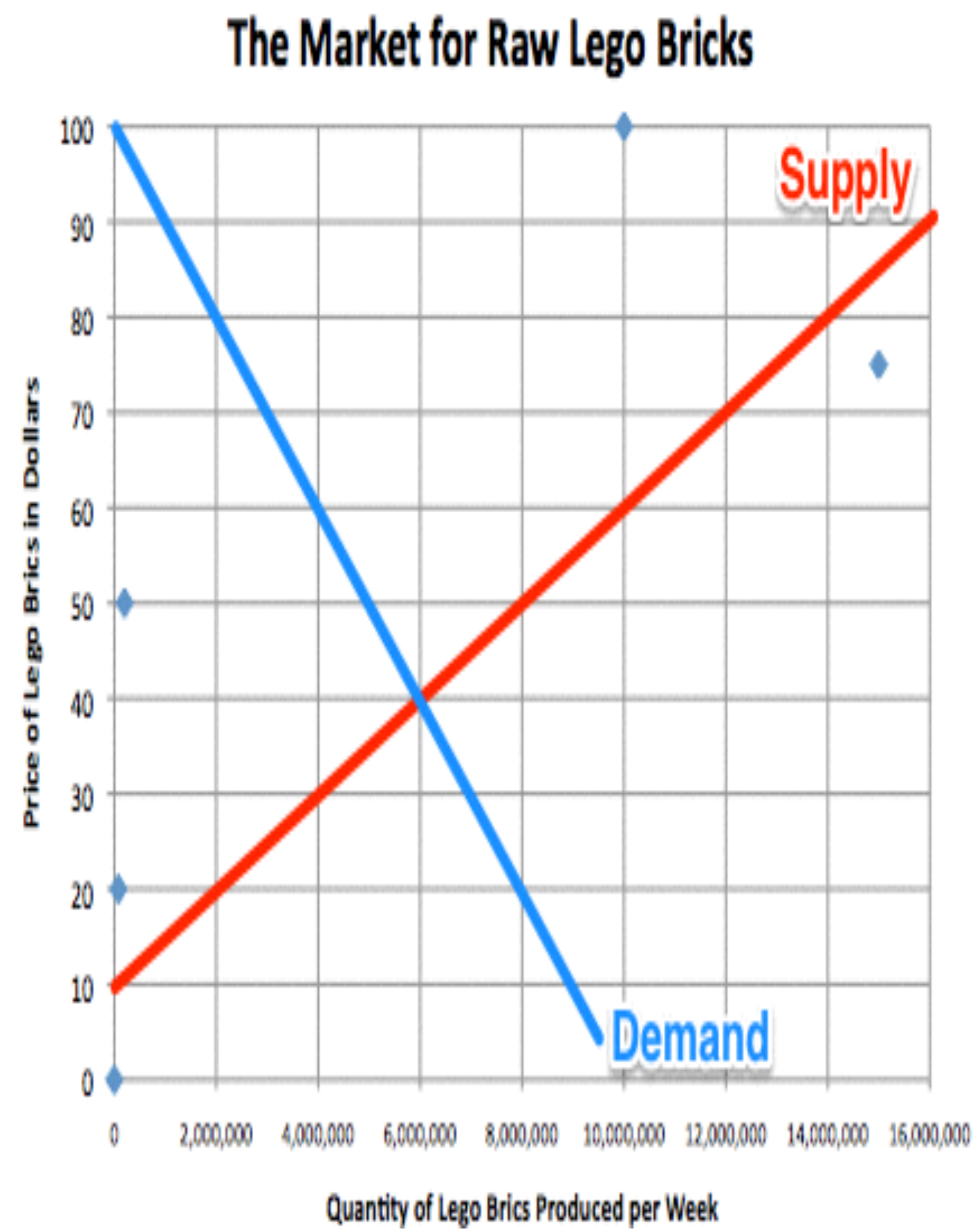
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics X

- Total Surplus:
  - $TS = Q(45+(P_d-P_s)/2)$
  - $TS = Q \times (45 + (100-0.00001Q-(10+0.000005Q))/2)$
  - $TS = Q(90-0.0000075Q)$
  - $TS = 90Q - 0.0000075Q^2$



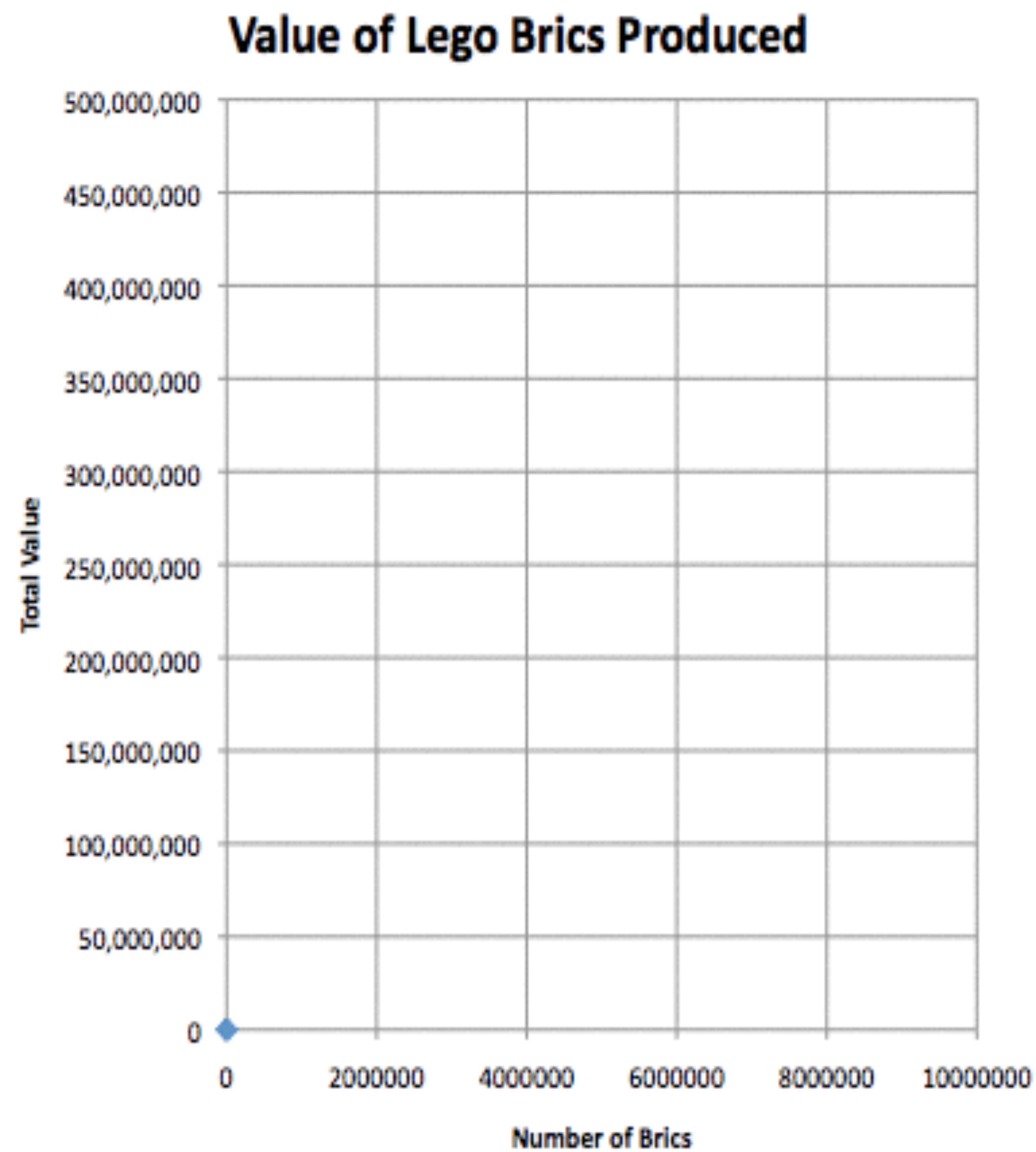
Our ~~Market~~ Omniscient, Benevolent Central Planner for Brics XI

- Total Surplus:
  - $TS = Q(45+(P_d-P_s)/2)$
  - $TS = Q \times (45 + (100-0.00001Q-(10+0.000005Q))/2)$
  - $TS = Q(90-0.0000075Q)$
  - $TS = 90Q - 0.0000075Q^2$
- Our BOCP wants to maximize this…



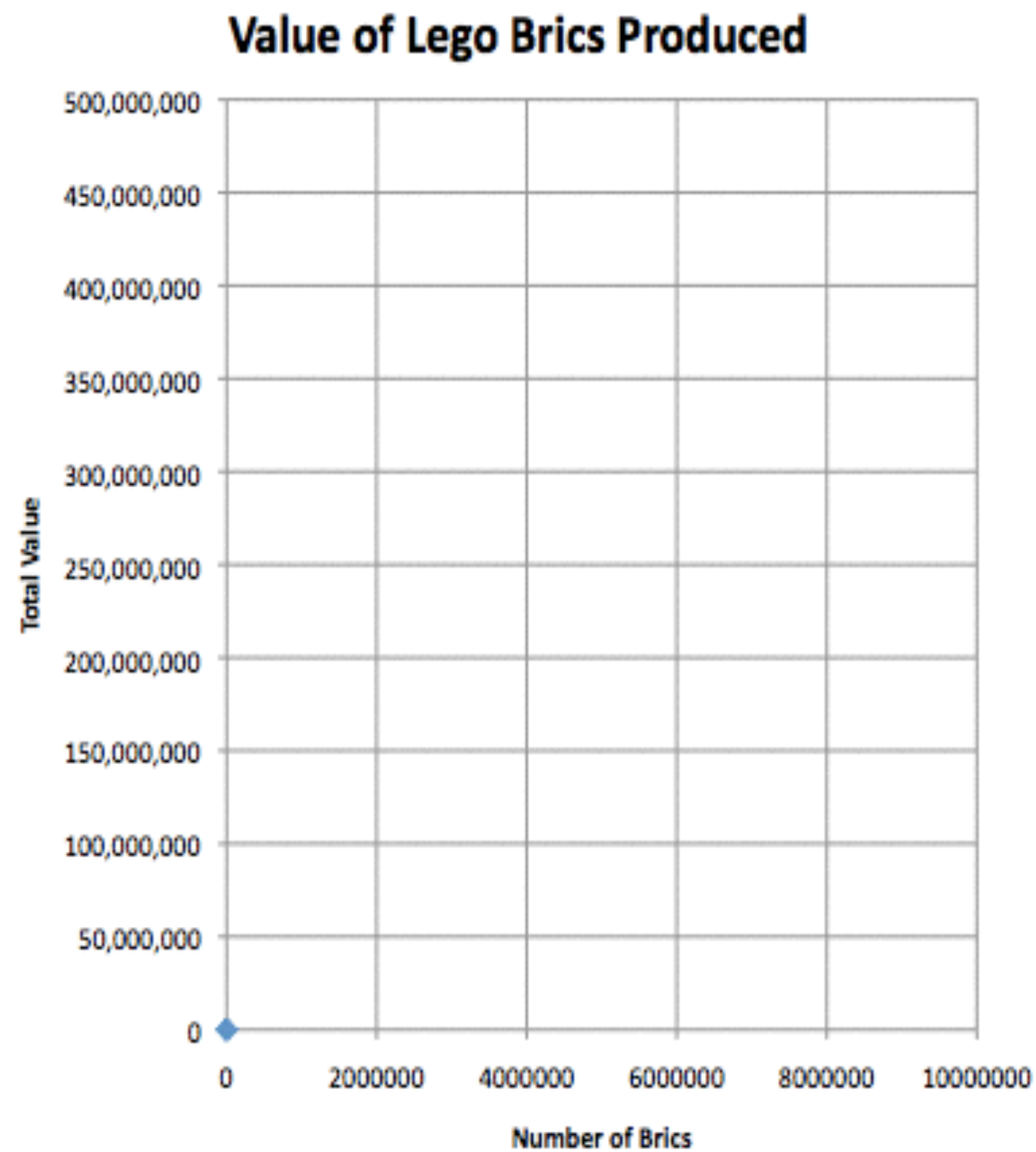
A More Visual Representation of Total Value

- For those of you for whom analytic geometry is close to your native language…
- A more graphical presentation might be useful…
- Let's start by calculating the value of brics to users…
- If no brics are used, the value of brics is zero…



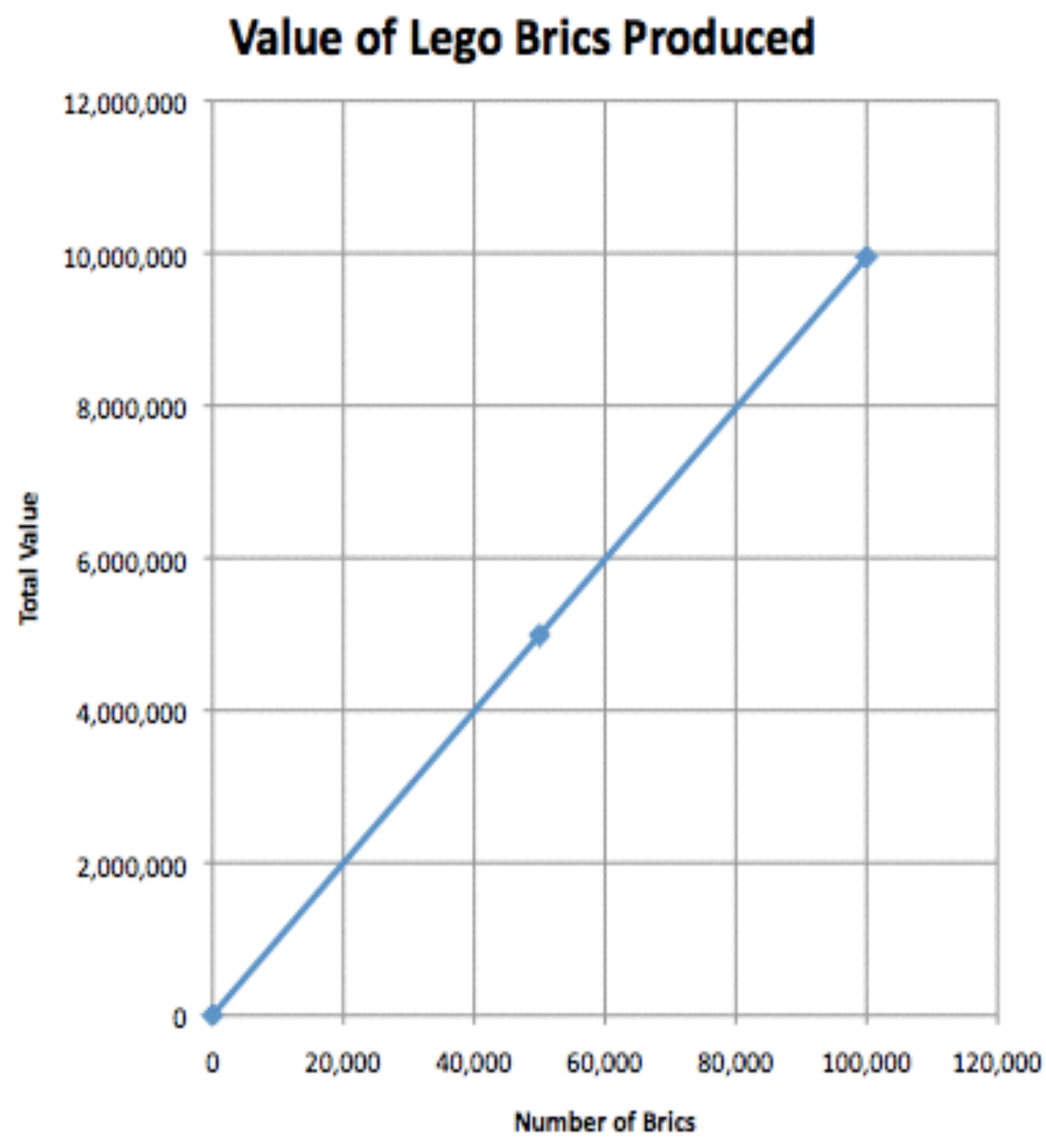
A More Visual Representation of Total Value II

- If no brics are used, the value of brics is zero…
- Suppose that we have some brics—is the plural of Lego “bric” “brics” or is it “brice”?—and master builders use them…
- Suppose we look at how much the master builders would be willing to pay for the first 100,000 brice…



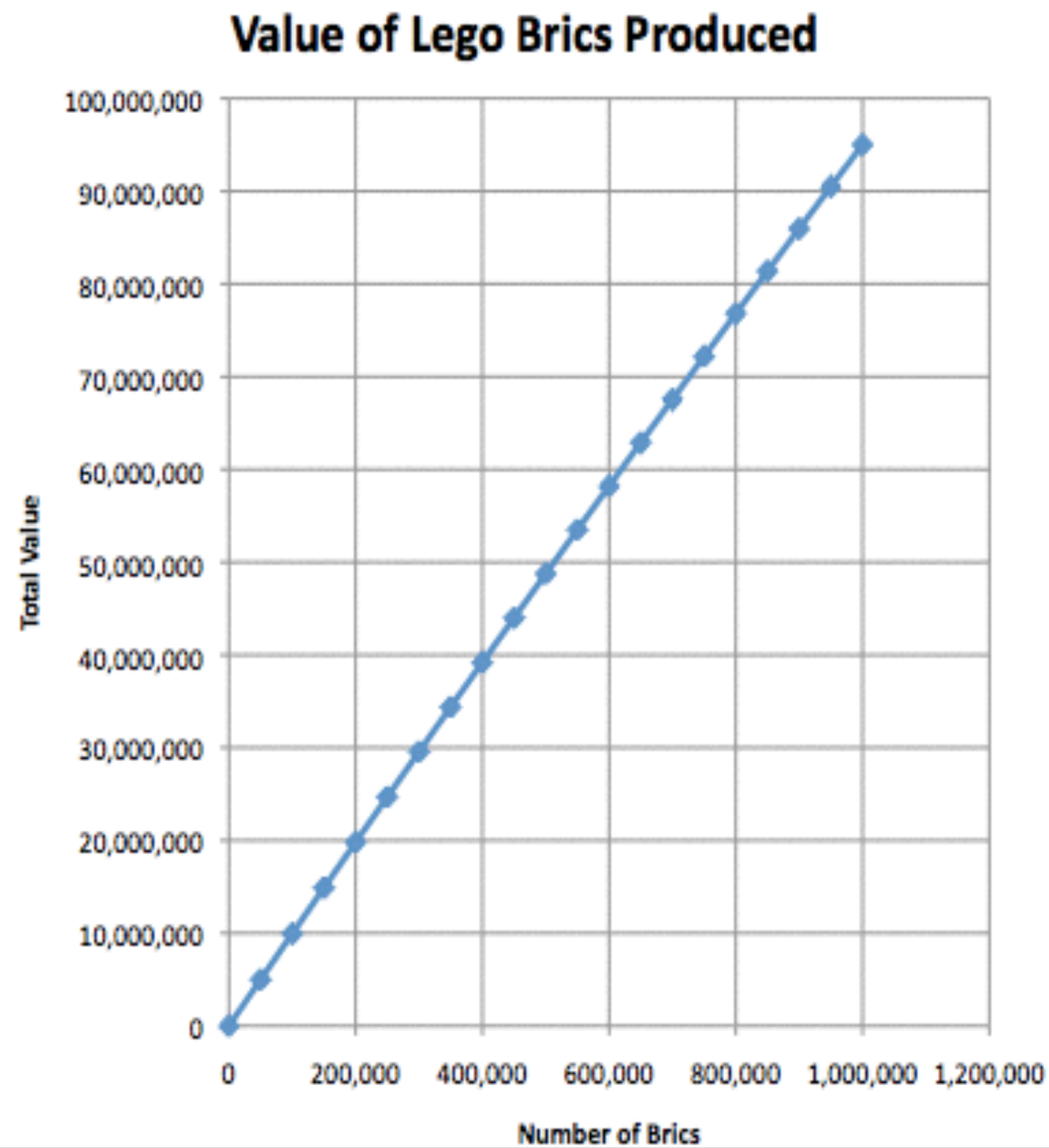
A More Visual Representation of Total Value III

- The first 100,000 brice are worth…
- Nearly 10,000,000…
- Actually, 9,950,000…
- The master builder who buys the 100,000th bric is not willing to pay 100 for it—he is only willing to pay 99 for it…
- So by the time you reach 100,000 brice, each extra bric you add is only adding 99 rather than 100 to the societal value…



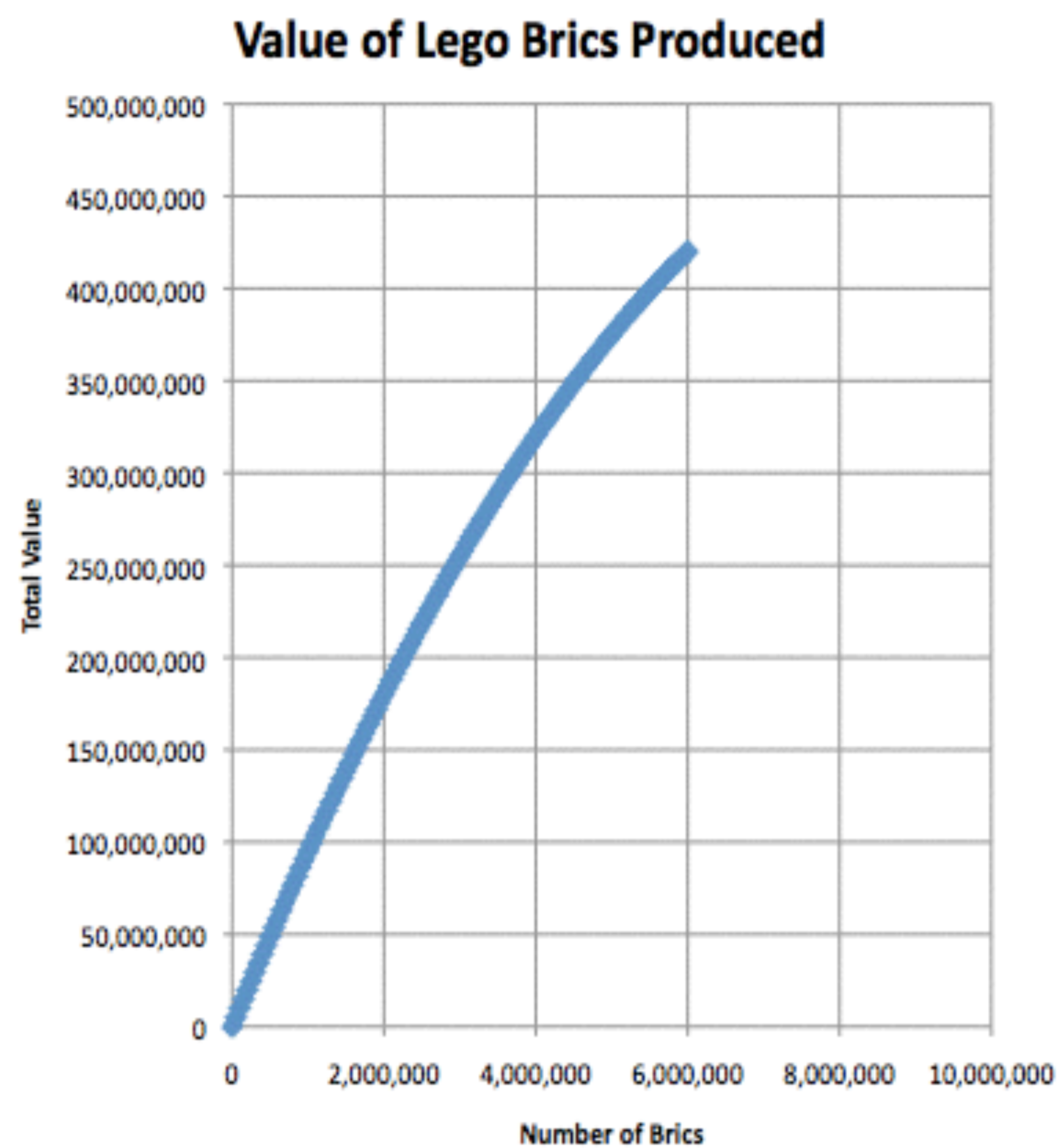
A More Visual Representation of Total Value IV

- The first 100,000 brice are worth 9,950,000…
- By the time you reach 100,000 brice, each extra bric you add is only adding 99 rather than 100 to the societal value…
- But keep on adding brice 100,000 at at time…
- And by the time you reach 1,000,000…
- The willingness-to-pay of the master builder who takes the 1,000,000th bric is only 90, and so each extra bric is only adding 90 to the total…
- And the total for the first 1,000,000 brice is up to 95,000,000



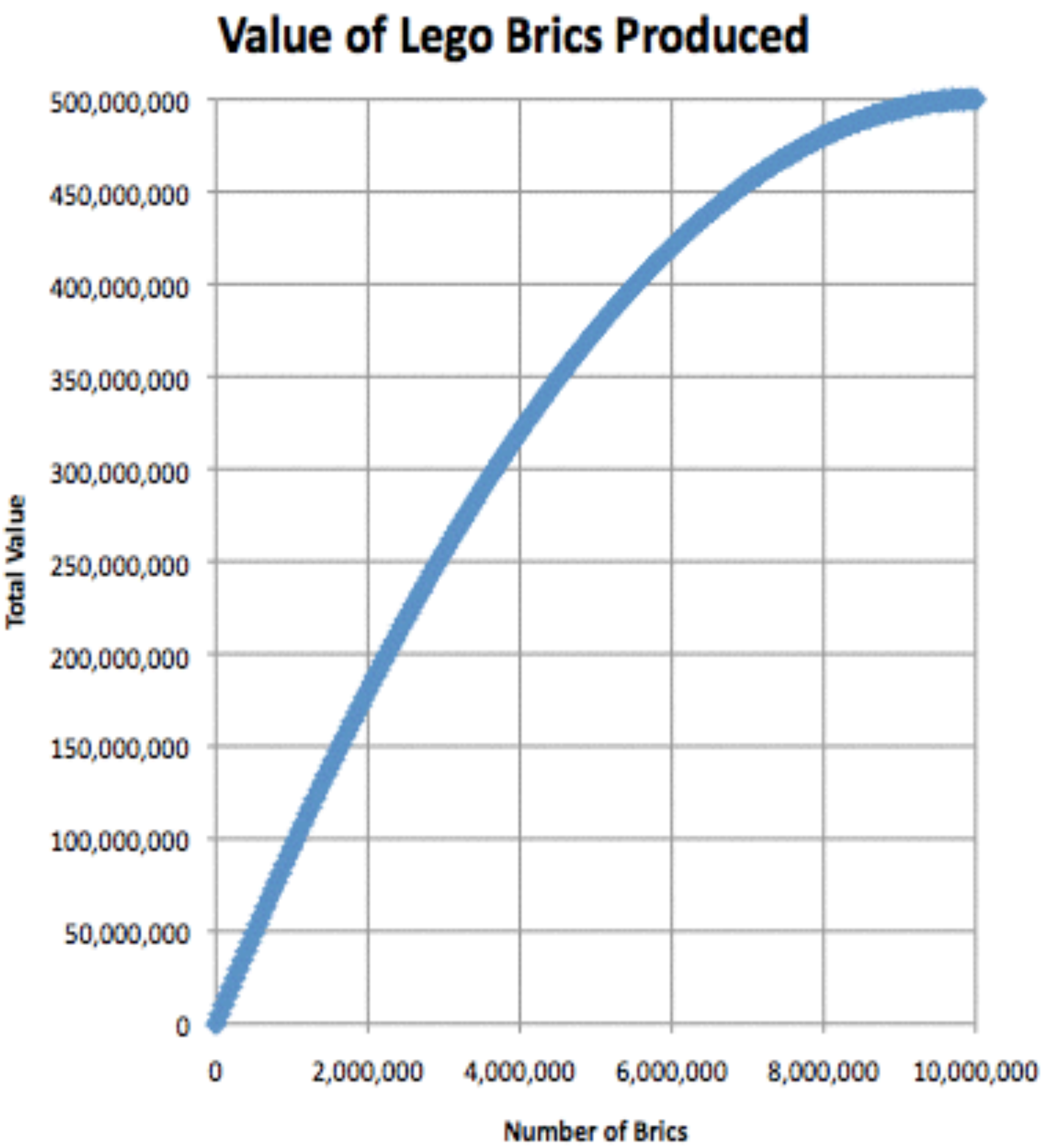
A More Visual Representation of Total Value V

- And the total for the first 1,000,000 brice is up to 95,000,000…
- But we keep on (hypothetically) finding more and more brice, and seeing what they are worth to the master builders who want them…
- By the time we reach 6,000,000 brice…
- The willingness-to-pay of the master builder who purchases the 6,000,000th bric is down to 40…
- And our total value is at 420,000,000—growing less than half as fast with each bric as it grew at the beginning…



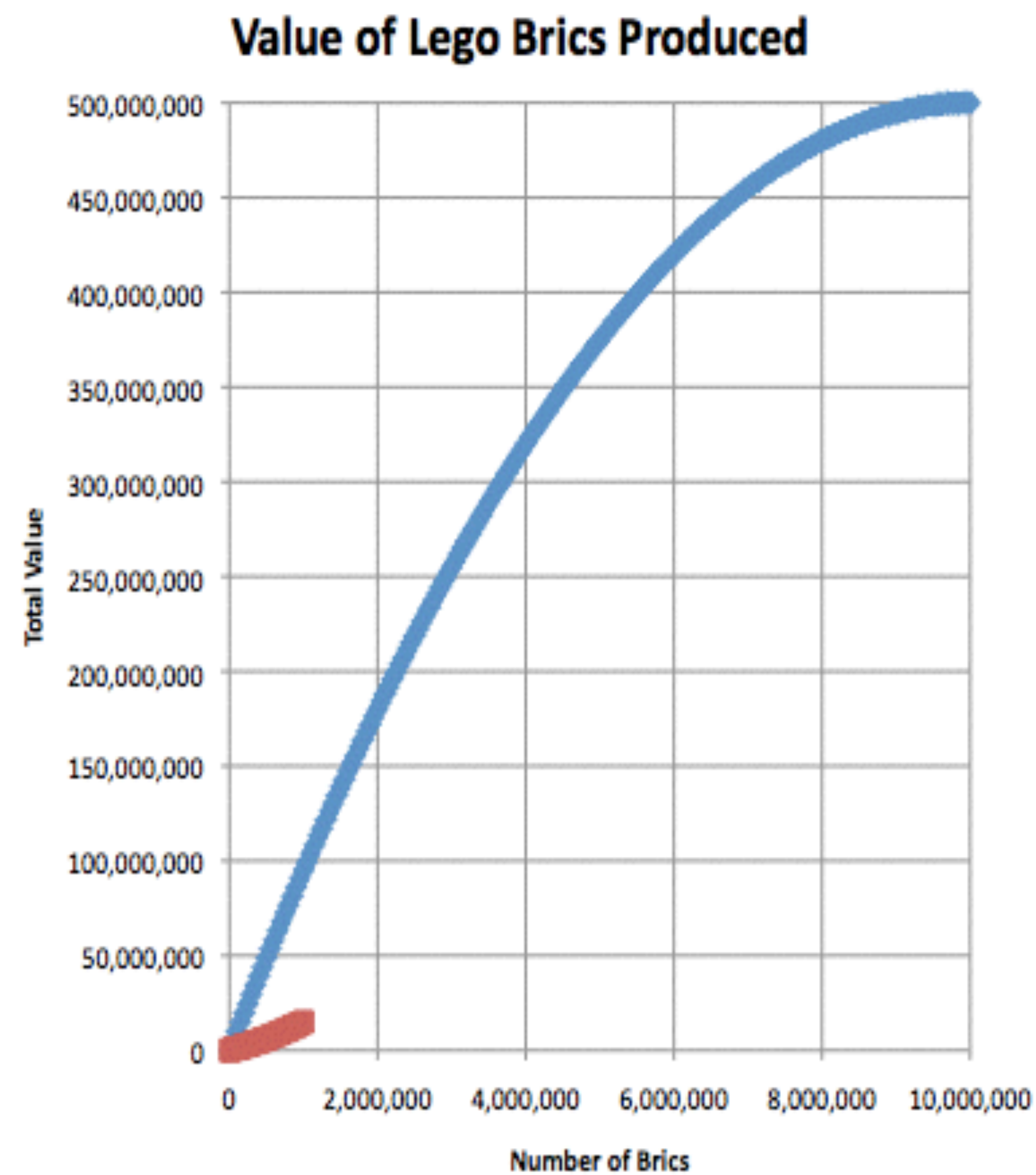
A More Visual Representation of Total Value VI

- And the total for the first 1,000,000 brice is up to 95,000,000…
- By the time we reach 6,000,000 brice, the willingness-to-pay is down to 40, and our total value is at 42,000,000…
- But we push further: on to 10,000,000 brice!
  - And we discover that bric 10,000,001 we can't give away…
  - And our total value has topped out at 500,000,000…



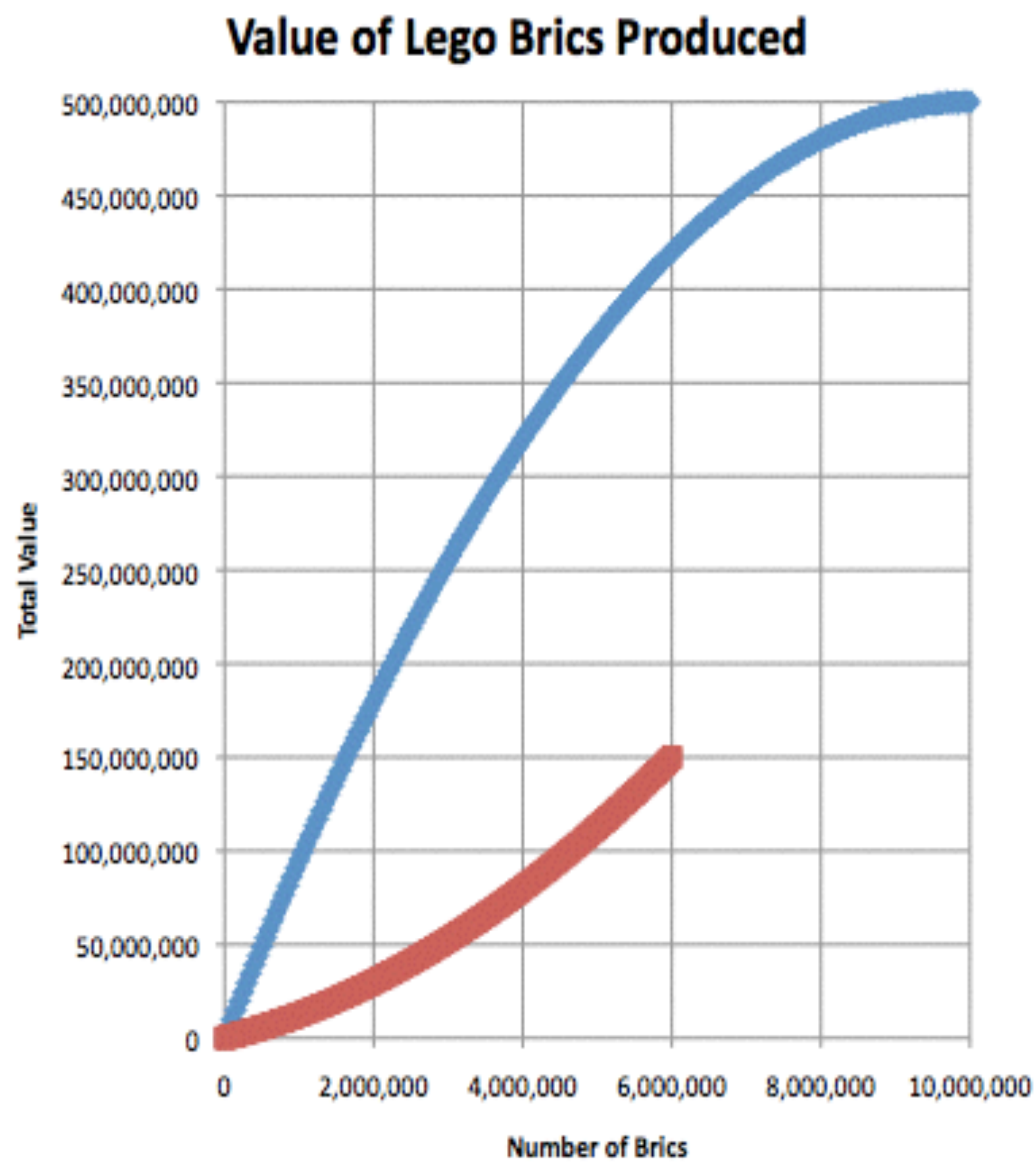
Plus a More Visual Representation of Total Cost

- We can do a similar graph for total cost, looking first at the 10 cost of producing the first bric…
- On up to the 15 cost of producing the millionth…
- With the total cost, as we add the opportunity cost of using the resources to make each bric up and up, of the first million brice amounting to 12,500,000…



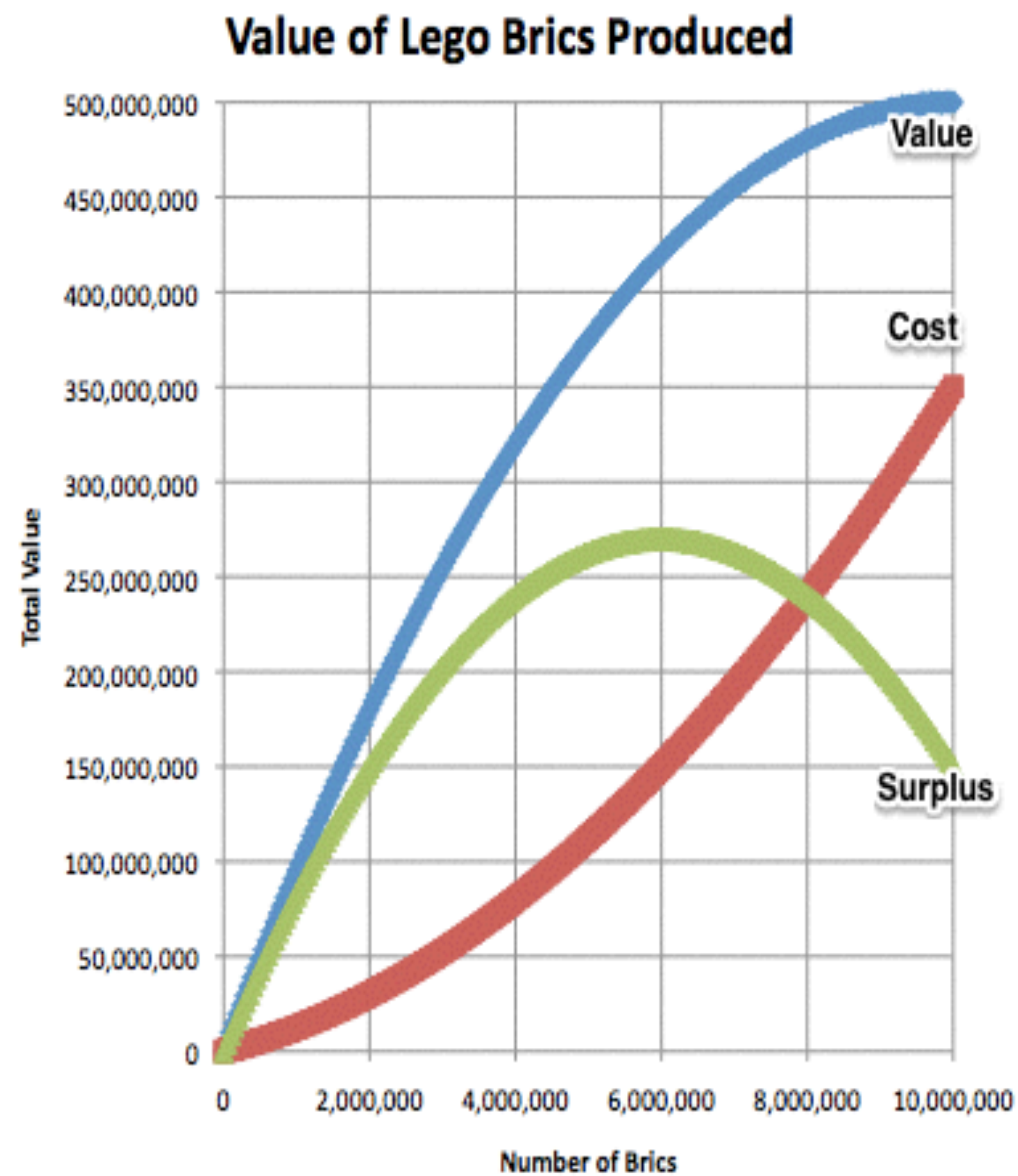
Plus a More Visual Representation of Total Cost II

- Looking first at the 10 cost of producing the first bric…
- On up to the 15 cost of producing the millionth. with the total cost of the first million brice at 12,500,000…
- And the 6,000,000 bric requires 40 in resources to call it forth, with a total cost of 150,000,000



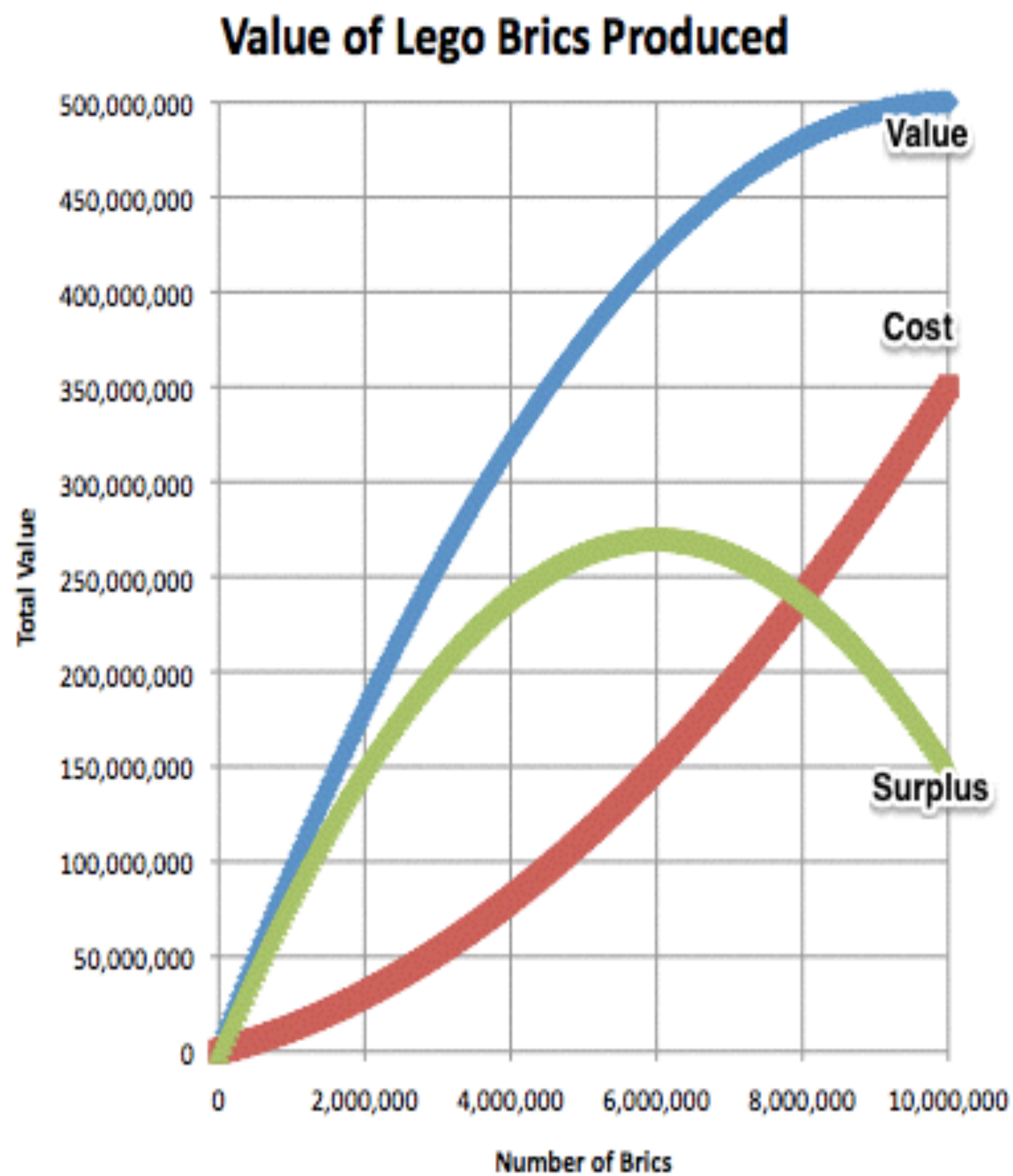
Value, Cost, and Surplus

- And by the 10,000,000th bric the marginal cost of the next bric is up to 60, and the total cost has reached 350,000,000…
- With the surplus being the gap between the “value” and “cost” curves…
- And with the job of the central planner being to choose the quantity that produces the highest outcome on the surplus curve…



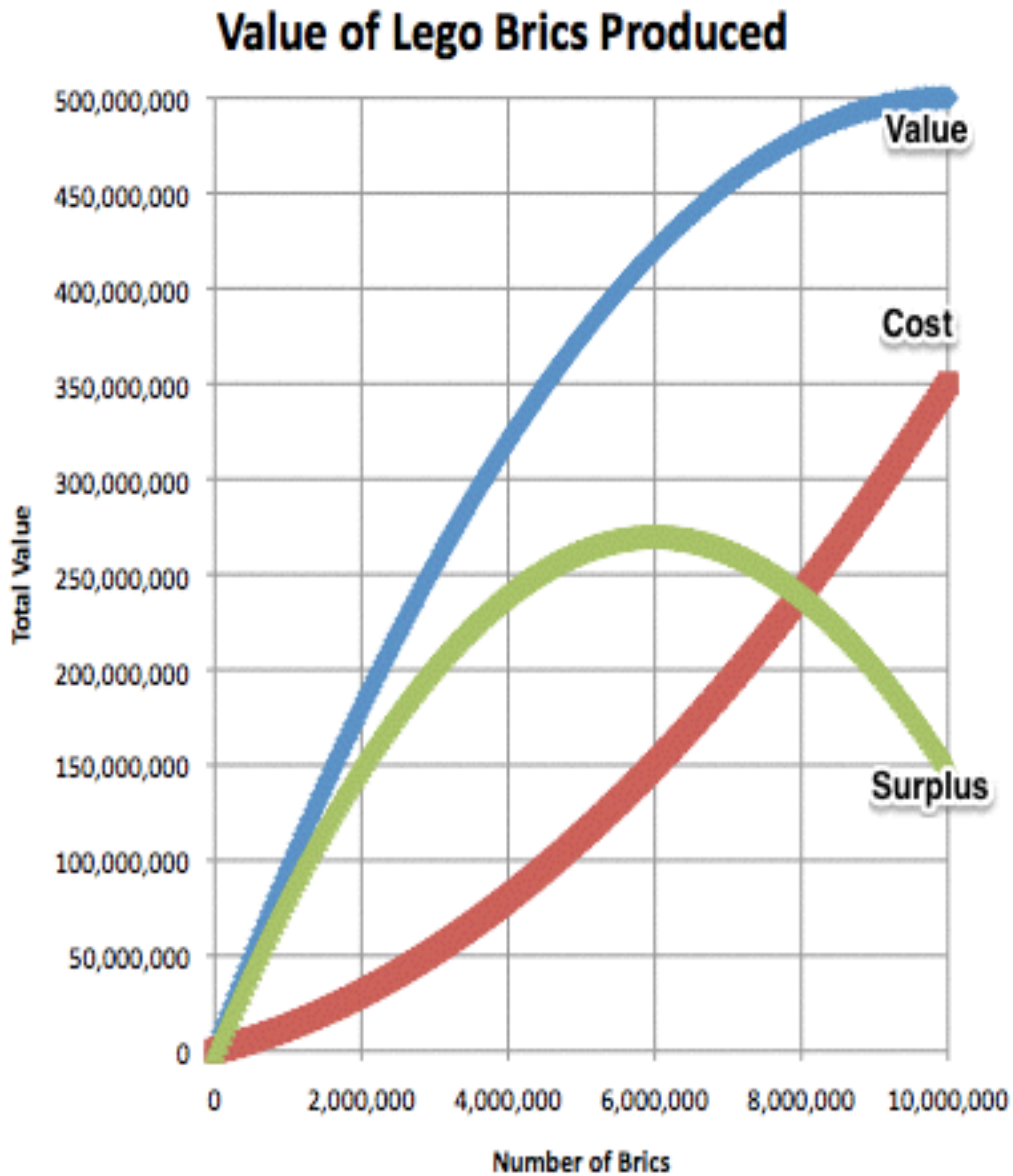
Value, Cost, and Surplus II

- All this is encapsulated in the three equations:
  - $TV=Q(100-0.00001Q/2)$
  - $TC=Q(10+0.000005Q/2)$
  - $TS=90Q-0.0000075Q^2$
- There is a lot of information packed into these few symbols, isn't there?
- To convey the same information would require a huge table, or oceans and oceans of words.



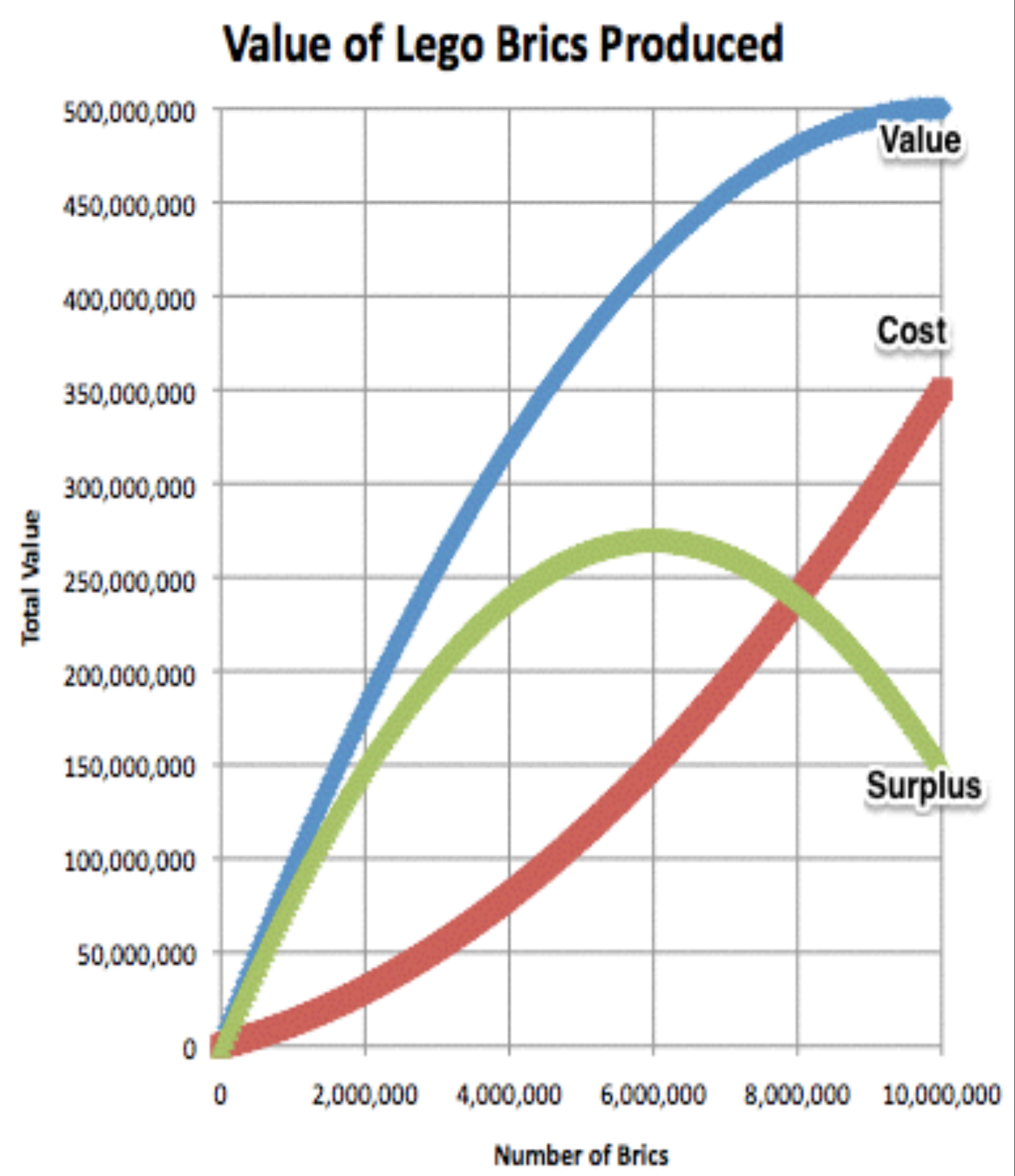
Value, Cost, and Surplus III

- And we could have been more abstract—left the parameters as parameters:
  - $TV=Q(P_{d0} - bQ/2)$
  - $TC=Q(P_{s0} + aQ/2)$
  - $TS=(P_{d0}-P_{s0})Q-(a+b)Q^2/2$
- And whatever conclusions we reach by manipulations of these three equations apply not just to the value, cost, and surplus for one possible quantity; to just to the value, cost, and surplus for all possible quantities for one supply and one demand curve…
- But to the value, cost, and surplus for every possible quantity and every possible (linear) supply and every possible (linear) demand curve…



Value, Cost, and Surplus IV

- But now that we have our surplus function:
  - $TS=(P_{d0}-P_{s0})Q-(a+b)Q^2/2$
  - $TS=(P_{d0}-P_{s0})Q-(a+b)Q^2/2$
- What do we do with it?



Ladies, Gentlemen, and Benevolent, Omniscient Central Planners, to Your i>Clickers!

- How do you pick a Q to maximize: TS = 90Q - $0.0000075Q^2$?
  - A. Take an integral!
  - B. Take a derivative!
  - C. Pick two values close together, see which one is higher, and then head off in that direction with another value of Q and repeat the process
  - D. Set up an Excel/Numbers spreadsheet with all possible quantity values
  - E. Do something else

Ladies, Gentlemen, and Benevolent, Omniscient Central Planners, to Your i>Clickers!: Answer

- How do you pick a Q to maximize: $TS = 90Q - 0.0000075Q^2$?
  - ~~A. Take an integral!~~
  - B. Take a derivative!
  - C. Pick two values close together, see which one is higher, and then head off in that direction with another value of Q and repeat the process
  - D. Set up an Excel/Numbers spreadsheet with all possible quantity values
  - E. Do something else
- **I'm not sure what (E) entails, but (B), (C), and (D) will all work…**
- **But the most insight can be gained via (B)…**

Taking a Derivative…

- Total Surplus:
  - $TS = 90Q - 0.0000075Q^2$
- Derivative:

Taking a Derivative II

- Total Surplus:
  - $TS = 90Q - 0.0000075Q^2$
- Derivative:
  - $d/dQ(TS) = d/dQ(90Q) + d/dQ(- 0.0000075Q^2)$

Taking a Derivative III

- Total Surplus:
  - $TS = 90Q - 0.0000075Q^2$
- Derivative:
  - $d/dQ(TS) = d/dQ(90Q) + d/dQ(- 0.0000075Q^2)$
  - $d/dQ(TS) = 90 + d/dQ(- 0.0000075Q^2)$
  - $d/dQ(TS) = 90 - 0.000015Q$

Figuring Out Where Total Surplus Is Maximized

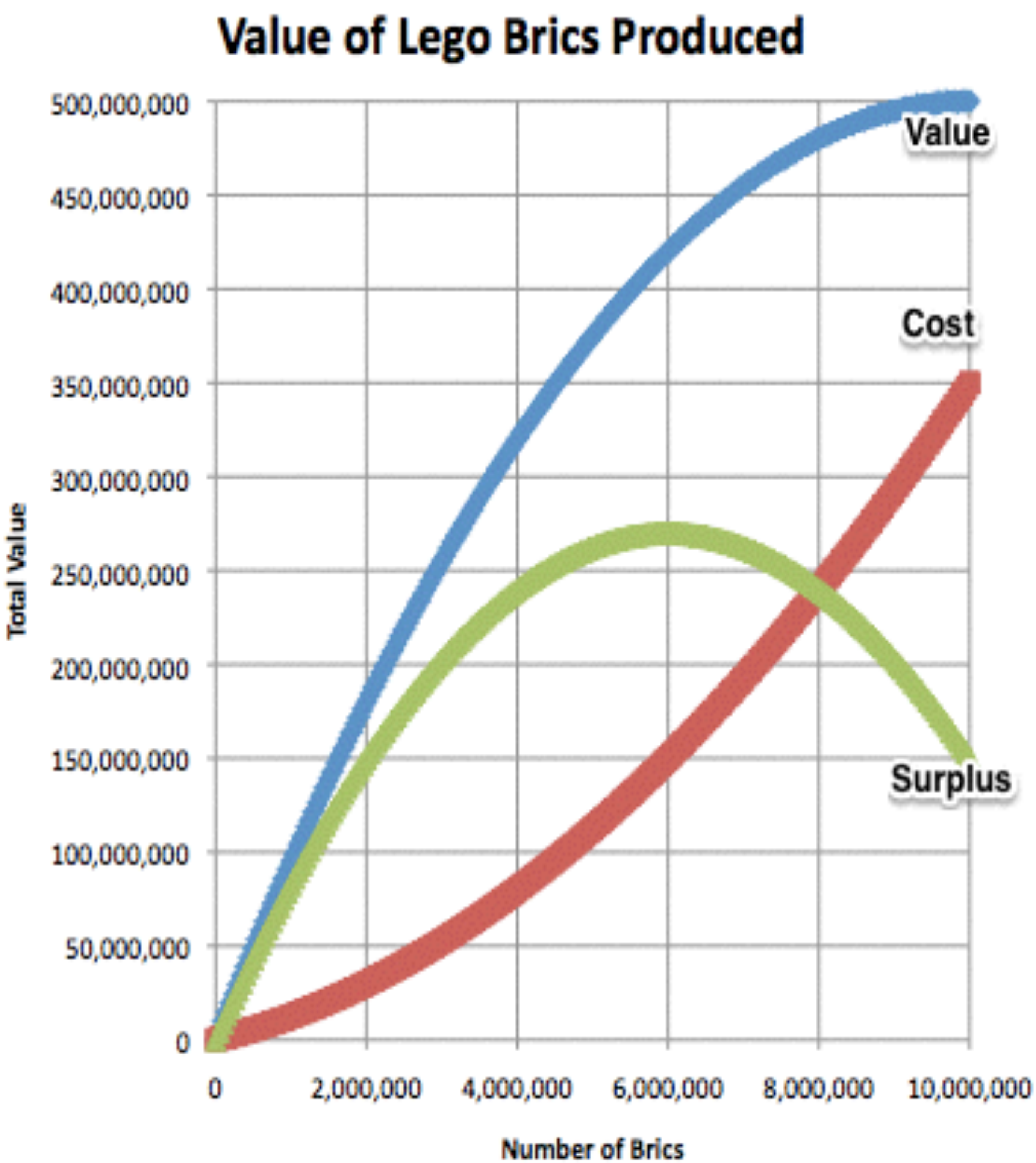
- Total Surplus:
  - $TS = 90Q - 0.0000075Q^2$
- Derivative:
  - $d/dQ(TS) = d/dQ(90Q) + d/dQ(- 0.0000075Q^2)$
  - $d/dQ(TS) = 90 - 0.000015Q$
  - $d/dQ(TS) = 0 \longrightarrow Q = 90/0.000015$

The Answer

- Total Surplus is maximized when:
  - d/dQ(TS) = 0 —> Q = 90/0.000015
- Q = 6,000,000

The Answer II

- Total Surplus is maximized when:
  - d/dQ(TS) = 0 —> Q = 90/0.000015
- Q = 6,000,000
- Which is not a terribly big surprise, is it?



More Generally…

- Total Surplus is maximized when:
  - $d/dQ(TS) = 0$ —> $Q = 90/0.000015$
- If I had not substituted in the numbers for the demand and supply curves—if I had kept them as:
  - Demand: $P_d = 100 - 0.00001Q$; $P_d = P_{d0} - b \times Q$
  - Supply: $Ps = 10 + 0.000005Q$; $P_s = P_{s0} + a \times Q$
- What would my equation $Q = 90/0.000015$ look like?

More Generally II…

- Total Surplus is maximized when:
  - $d/dQ(TS) = 0$ —> $Q = 90/0.000015$
- If I had not substituted in the numbers for the demand and supply curves—if I had kept them as:
  - Demand: $P_d = 100 - 0.00001Q$; $P_d = P_{d0} - b \times Q$
  - Supply: $Ps = 10 + 0.000005Q$; $P_s = P_{s0} + a \times Q$
- What would my equation $Q = 90/0.000015$ look like?
- It would be: $\mathbf{Q = (P_{d0} - P_{s0})/(a + b)}$
  - Where have we seen that equation before?

Our Market Is, for All Intents and Purposes, an Omniscient, Benevolent Central Planner for Brics

- Total Surplus is maximized when:
  - $d/dQ(TS) = 0$
  - $Q = 90/0.000015$
  - $Q = (P_{d0} - P_{s0})/(a + b)$
  - $Q = 6{,}000{,}000$
- **The competitive market in equilibrium carries out exactly the calculation that a benevolent, omniscient central planner would carry out**
  - **And the CMiE does not then have to boss people around to get them to carry out its plan**

Our Market *Is*, for All Intents and Purposes, an Omniscient, Benevolent Central Planner for Brics

- **Let me repeat that:**
- **THE COMPETITIVE MARKET IN EQUILIBRIUM CARRIES OUT EXACTLY THE CALCULATION THAT A BENEVOLENT, OMNISCIENT CENTRAL PLANNER WOULD CARRY OUT**
  - **And the CMIE does not then have to boss people around to get them to carry out its plan**

But: Back to Our Pollution Problem

- We have three stakeholders in this market:
  - Value to consumers:
    - TV = Q x $(P_{d0} + P_d)/2$
  - Cost to producers:
    - TC = Q x $(P_{s0} + P_s)/2$
  - But also: xternality cost to Cloud-Cuckoo Landers:
    - XC = $-(P_x)Q$
  - The competitive market maximizes TV-TC.
  - But the BOCP sees the externality XC as well.
  - What would the BOCP do?