Gaining an Operational Edge: Piece-Picking Process Optimization

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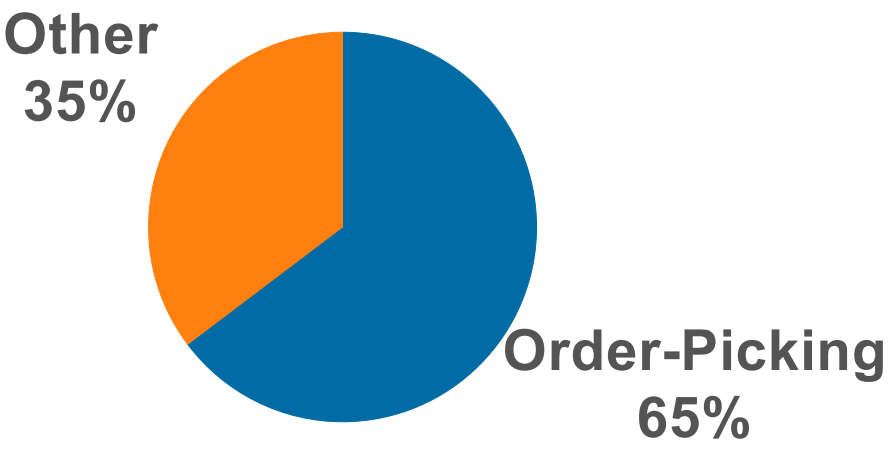
Our Thesis Sponsor Company & Their Operational Context

- US retailer: mainly low-cost daily items
- Manual piece-picking, labor-intensive and costly
- % of order-picking in warehouse operating expenses:



- Operational context
  - Weekly replenishment from DC to store based on forecast
  - Weekly shipment of 1 SKU to 1 store = 1 pick (bin visit)
  - Pick multiple for each SKU is DC-wide

The Proposed Improvement Scheme

- Change pick multiple for some SKUs from 1 to 2 (even numbers only)
- Foreseeable impact:
  - Increase units per pick
  - Reduce picks (bin visits)
  - Shift of DC inventory to store (increase in store inventory)

Week (shipment)	1	2	3	4	5	6	7
Qty before change	1	1	3	3	0	2	0
Qty after change	2	0	4	2	0	2	0

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Data & Methodology

- 74 weeks of weekly shipment quantities for each SKU
- Looked at 5 stores, 1 DC, with 10,000+ SKUs per store
- Simulation: MySQL recursive procedures, shipment quantities after change for every SKU
- Calculated pick reduction & unit*weeks of extra inventory in store

Week (shipment)	1	2	3	4	5	6	7
Qty before change	1	1	3	3	0	2	0
Qty after change	2	0	4	2	0	2	0

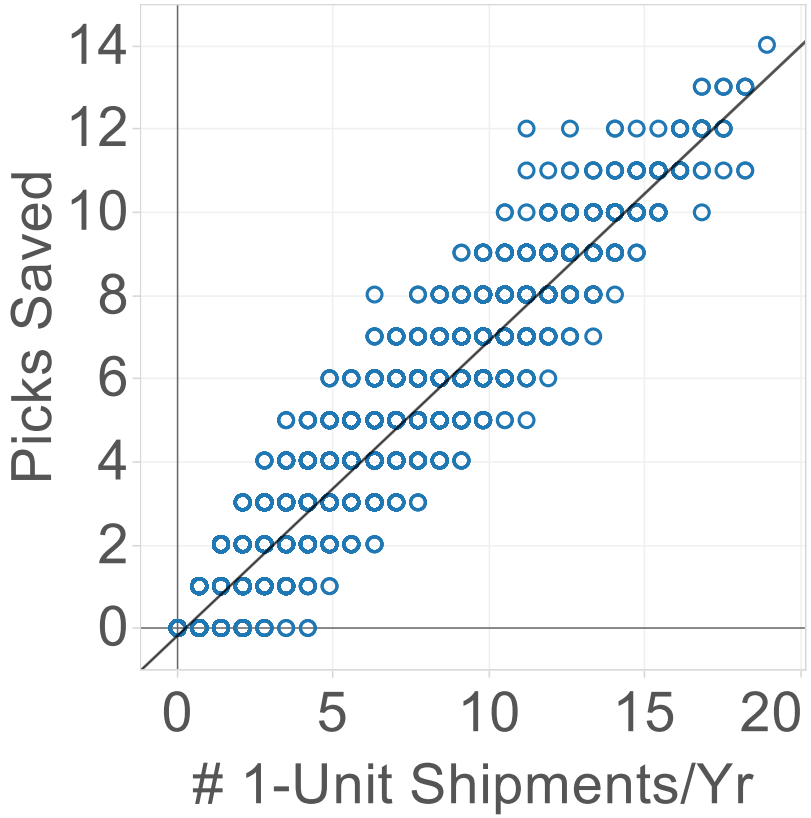
Week (shipment)	1	2	3	4	5	6	7
Qty before change	1	0	0	0	0	3	4
Qty after change	2	0	0	0	0	2	4

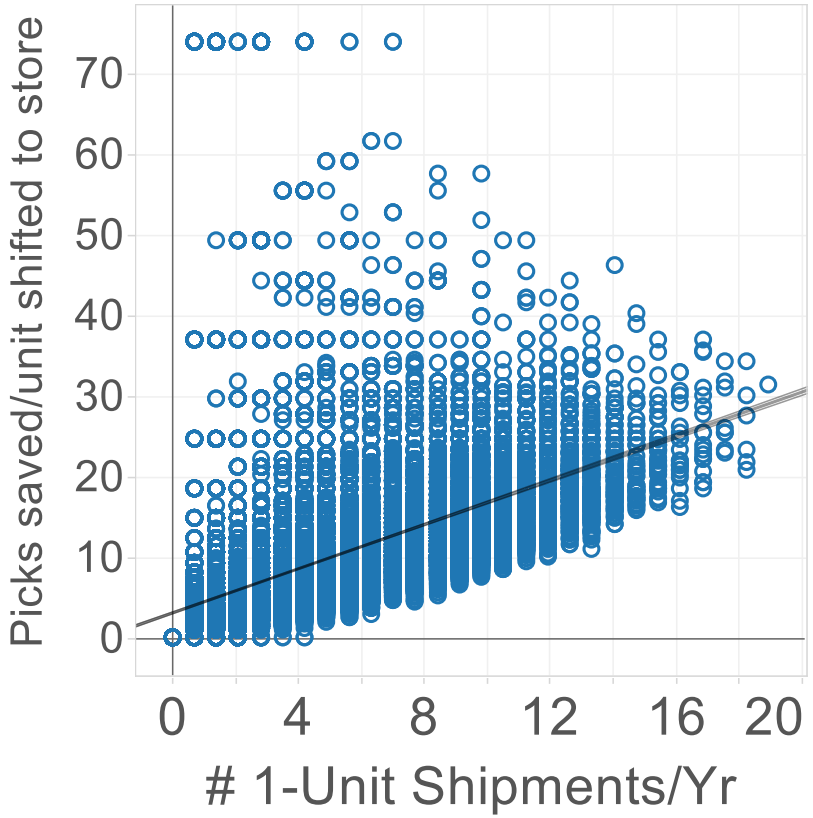
Methodology Continued: SKU Segmentation

- Goal: identify SKUs that provide a large savings in picks and picking cost for as little increase in store inventory as possible (shift from DC)
- 2 ratios of SKU goodness for the scheme
  - Ratio 1 = $\#\ Picks\ saved / Inventory\ shifted\ to\ store$
  - Ratio 2 = $\$\ Picking\ cost\ saved / \$\ Value\ of\ inventory\ shifted\ to\ store$
- SKUs with large ratios: large pick savings and small inventory impact
- Segmented SKUs by 3 variables to predict the ratios:
  - Variable 1: Number of 1-unit shipments/year
  - Variable 2: SKU unit cost
  - Variable 3: Shipment frequency

Variable 1: Number of 1-Unit Shipments/Year

Week	1	2	3	4	5	6	7	8	9
Qty before	1	0	0	1	3	1	0	1	1
Qty after	2	0	0	0	4	0	0	2	0





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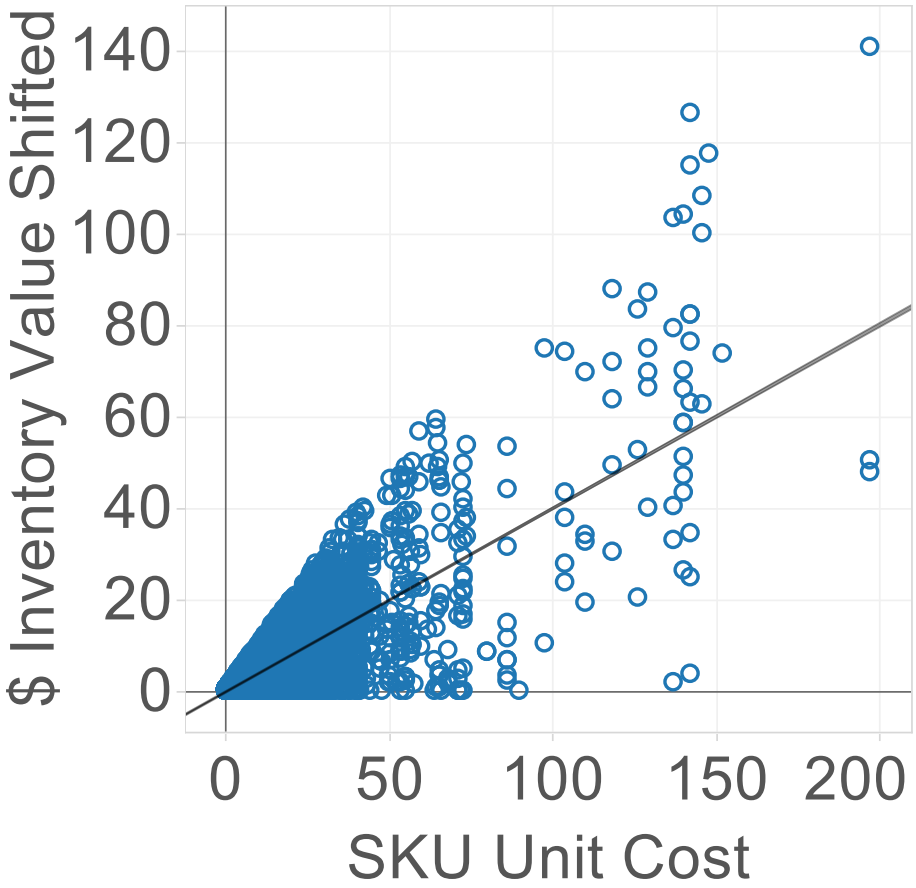
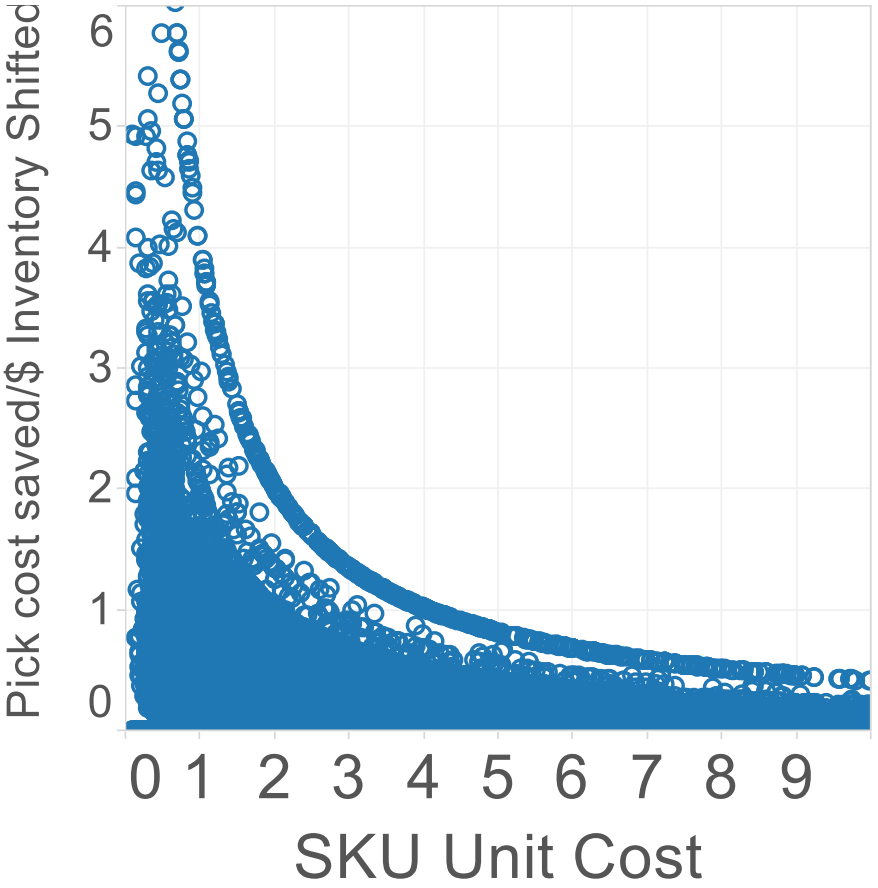
Variable 2: SKU Unit Cost





- Negative correlation between SKU cost & ratio 2, “$ picking cost saved / $ value of inventory shifted to store”
- As SKU cost increases, the ratio is likely to decrease

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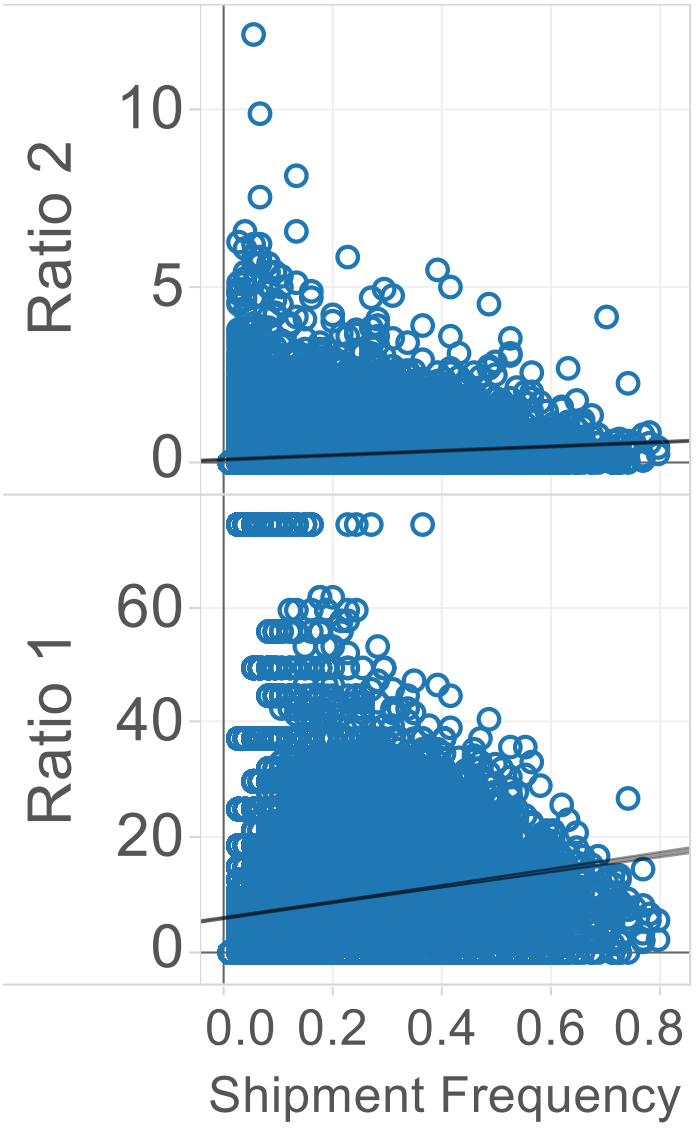
Variable 3: Shipment Frequency

- Shipment frequency used to capture "gap" between shipments
- It is not as correlated with the ratios
- BUT it is highly correlated with the number of 1-unit shipments
- Therefore, we excluded this variable



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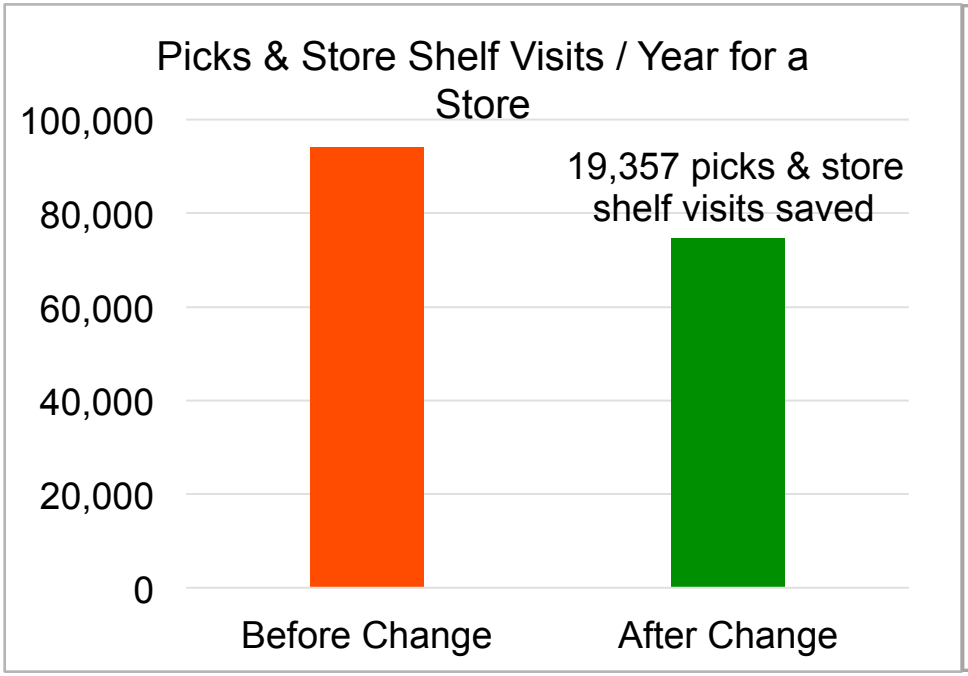
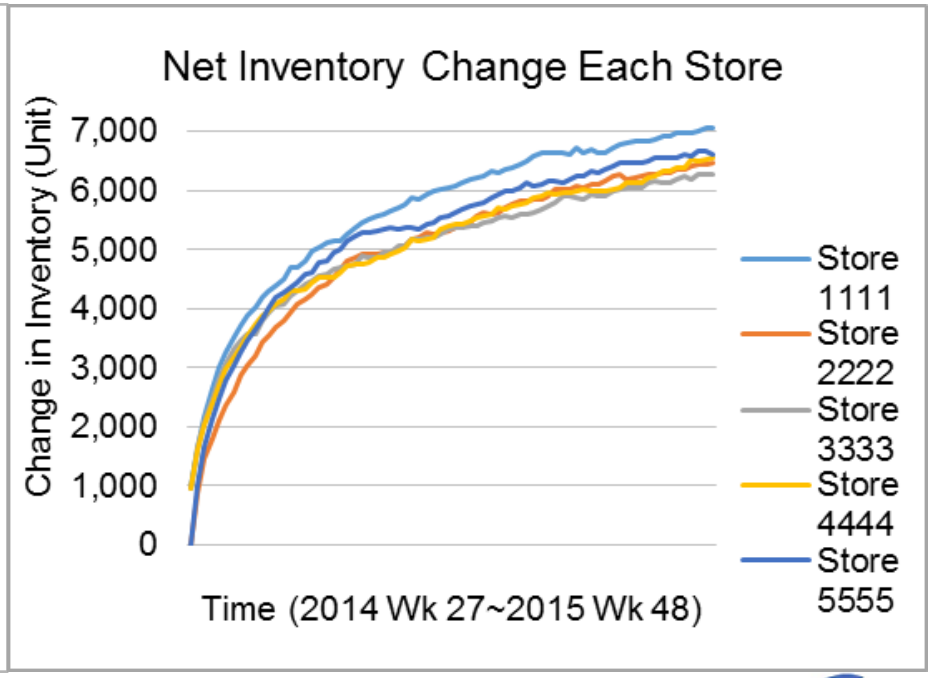
Results 1: Simulation on ALL SKUs

- Savings: around 20% picks & store shelf visits
- Picking efficiency: +0.65-0.69 units/pick per store
- Inventory impact: scheme prepositioning units to store, store level increases towards plateau outside data range
  - Extrapolated net increase: 7,600-8,600 units each store (6%-7% increase)
  - Need SKU segmentation to find suitable SKUs





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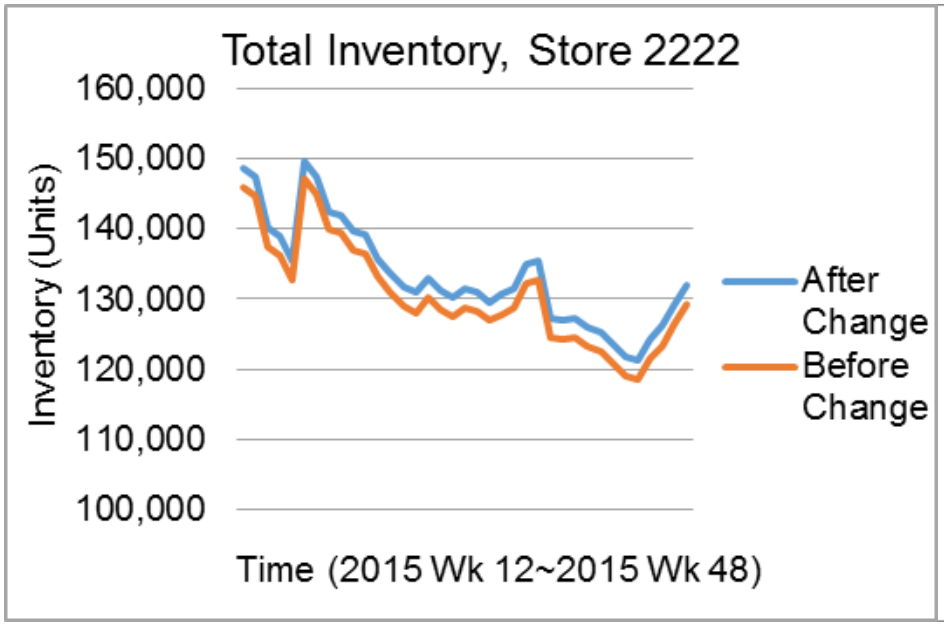
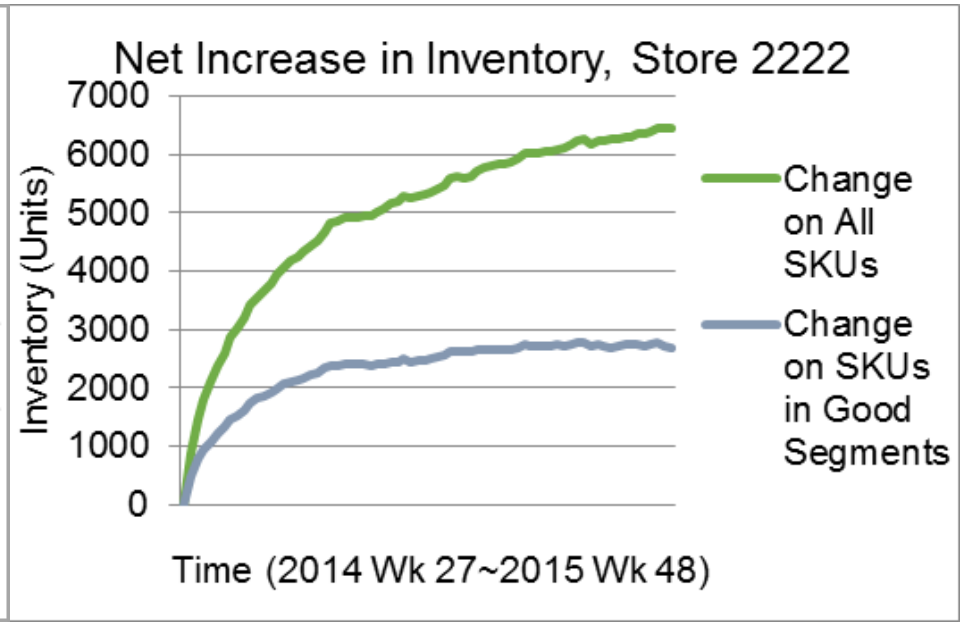
Results 2: Simulation on SKUs in Good Segments across DC

- Good segments: high / medium # 1-unit shipments & low SKU cost

Store #	Store 1	Store 2
SKU in Store	SKU 1234	SKU 1234
Good Segment or Not	Segment good for scheme	Segment not good for scheme

- Savings: 11%-13% picks & store shelf visits and their costs
- Picking efficiency: +0.36-0.38 units/pick per store, +0.61 units/pick for SKUs

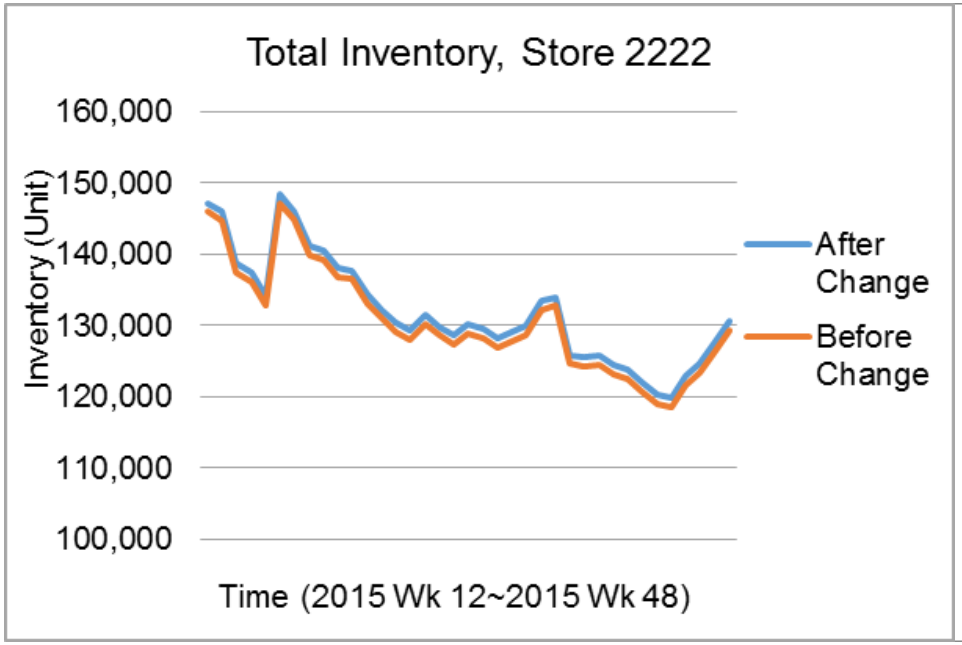


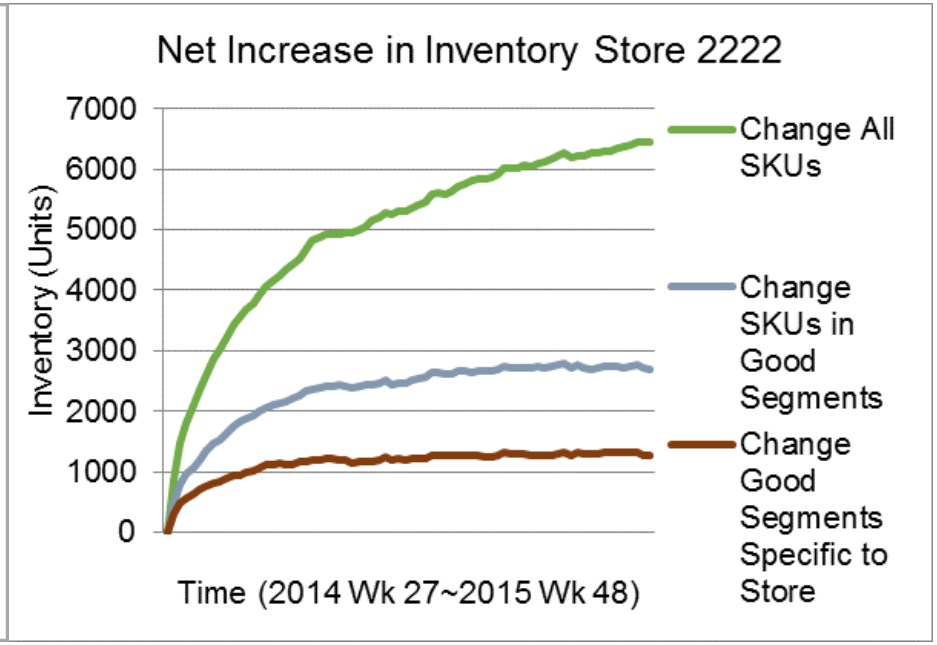


Results 3: Simulation on Suitable SKUs Specific to Store

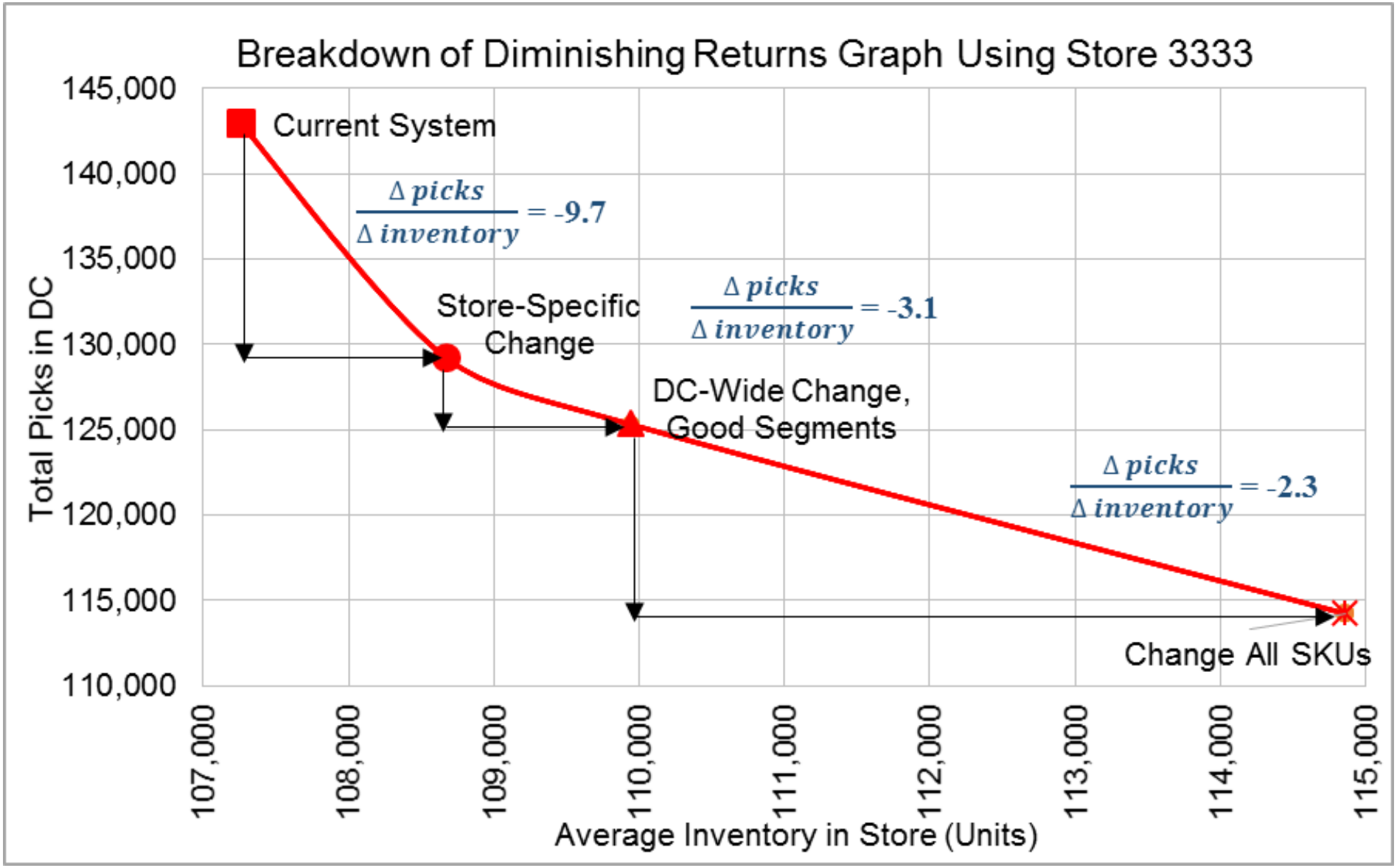
Store #	Store 1	Store 2
SKU in Store	SKU 1234	SKU 1234
Good Segment or Not	Segment good for scheme	Segment not good for scheme

- Savings: 8.9%-10.5% picks & shelf visits
- Picking efficiency: +0.24-0.28 units/pick each store, +0.71 units/pick for SKUs changed





Diminishing Returns on Pick Multiple Change



Conclusion & Discussion

- Change in pick multiple does **increase efficiency and reduce cost**, but with impact on inventory in the stores
- SKU segmentation helps find SKUs that can reduce the **most cost** with the **least inventory impact**
- More **specific pick multiple change** generates greater savings per inventory impact vs. operational complexity
- Applicability of pick multiple change
  - Perishability
  - SKU size issues
  - Integrated forecast/replenishment system
- Scheme is simple, viable and contingent on the above conditions

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Questions & Comments?

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