BALANCING PRODUCT FLOW AND SYNCHRONIZING TRANSPORTATION

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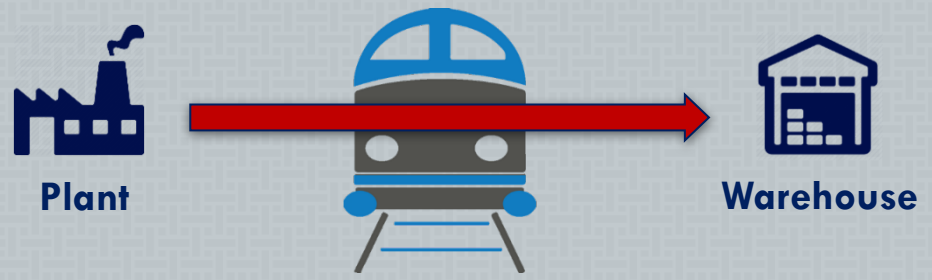
Massachusetts Institute of Technology

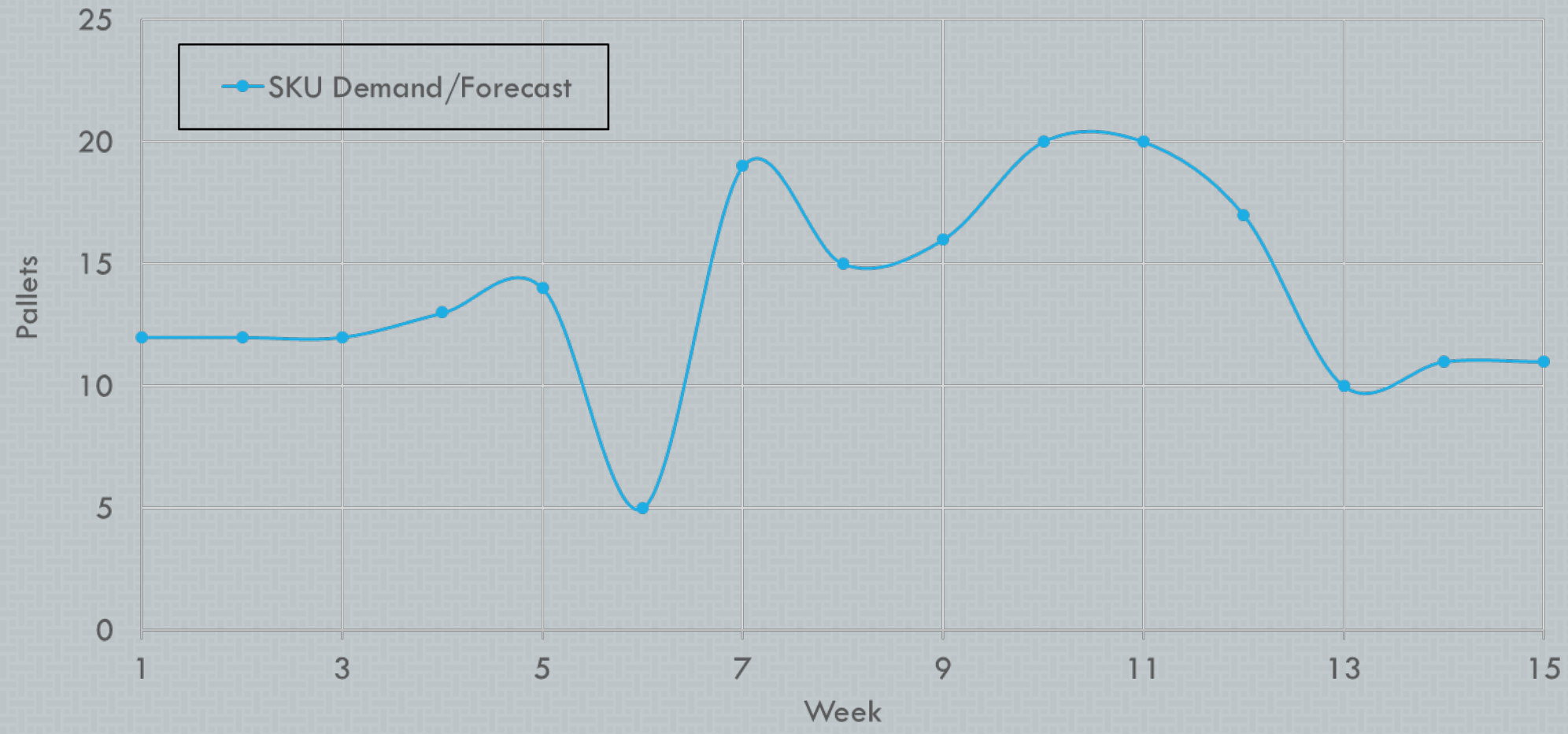
SCM

AGENDA

- Project Overview
- Methodology
- Model Output
- Next Steps

PROJECT OBJECTIVE





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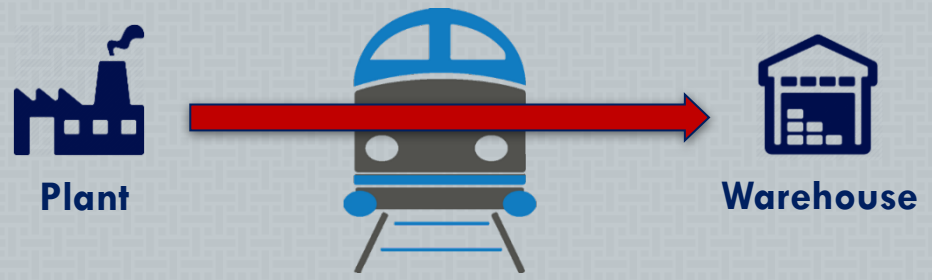
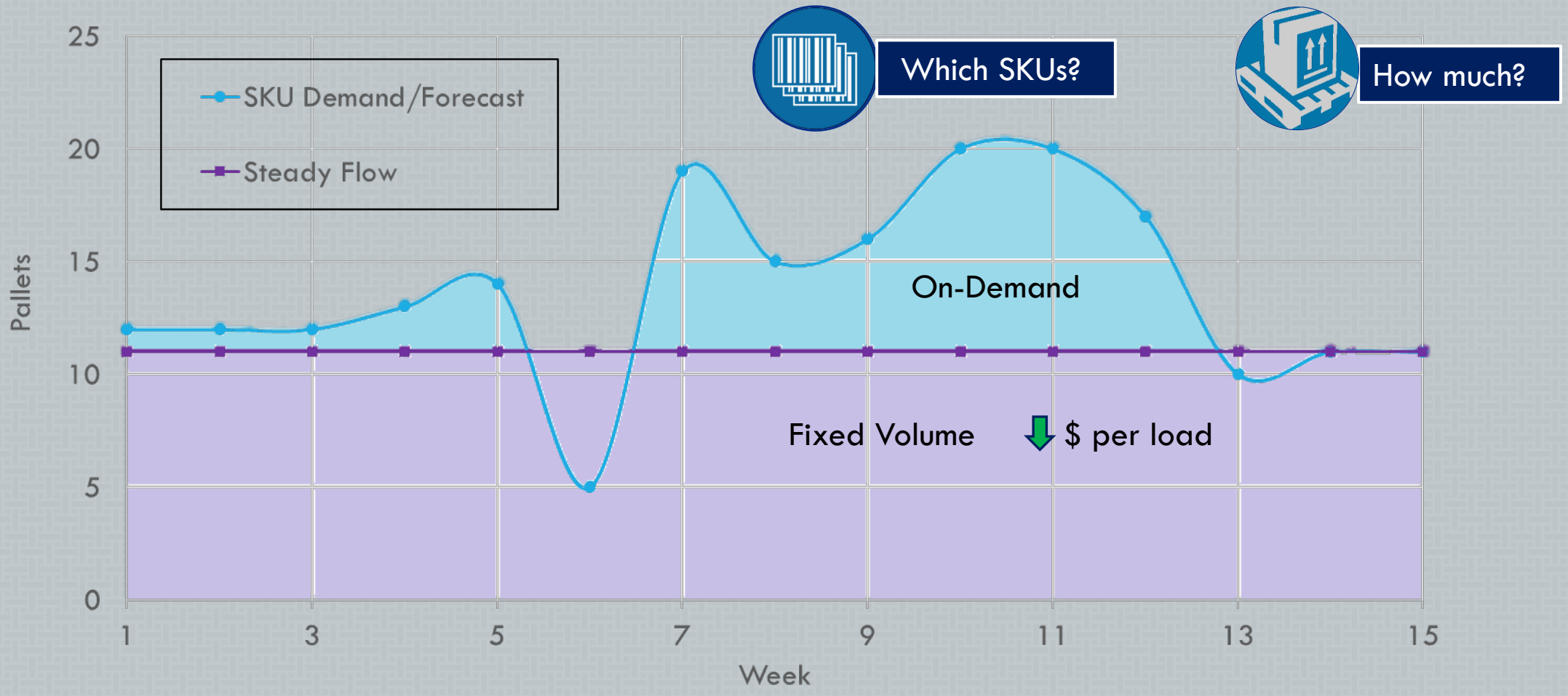
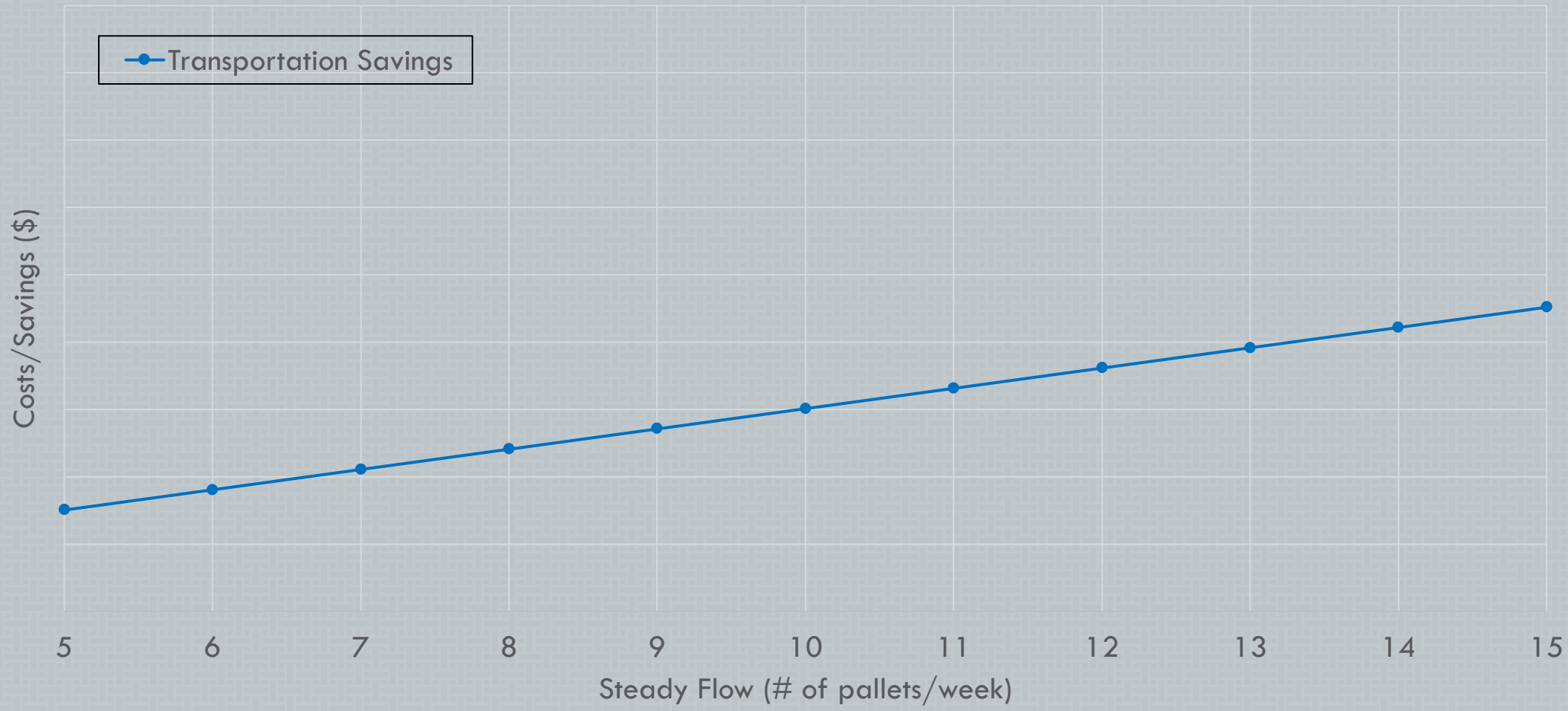




STEADY FLOW TRADE-OFFS



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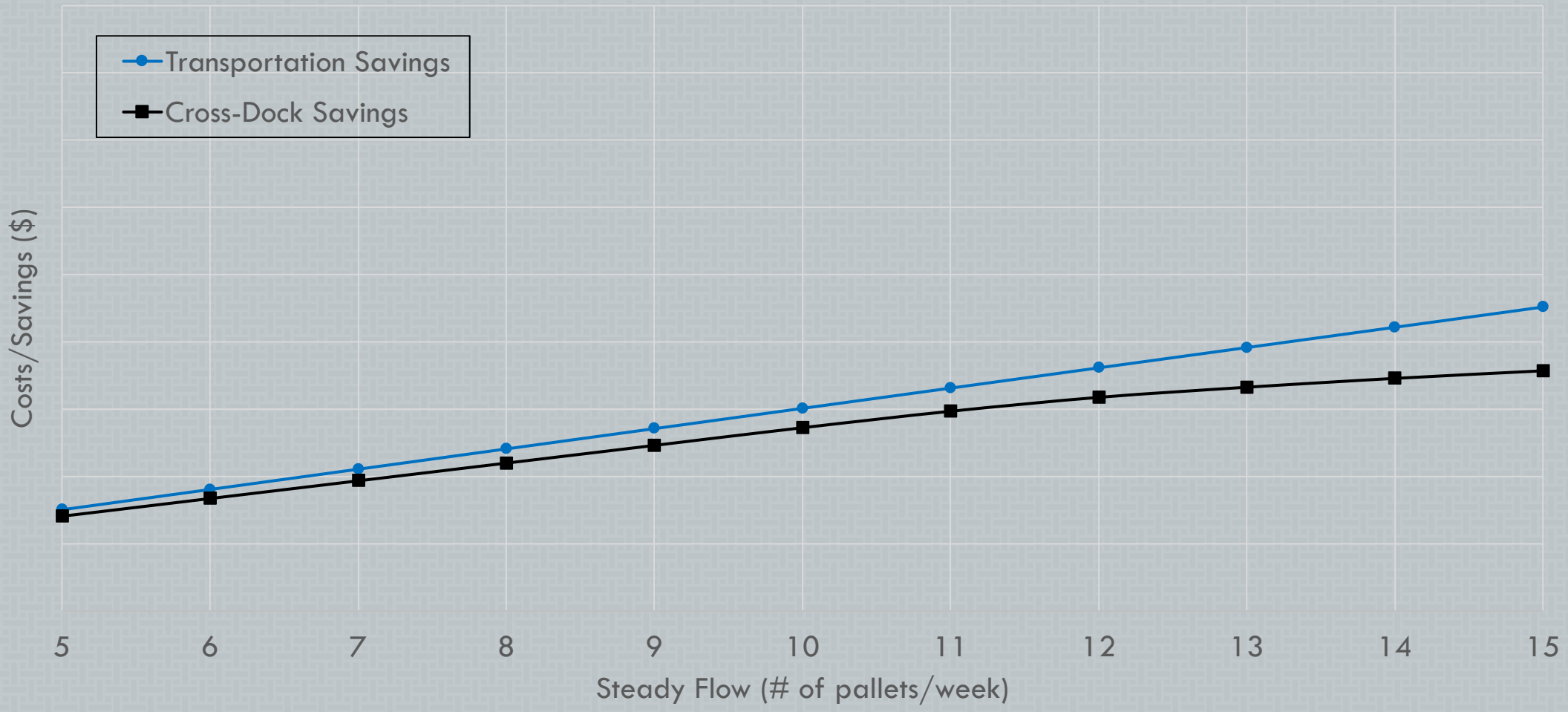

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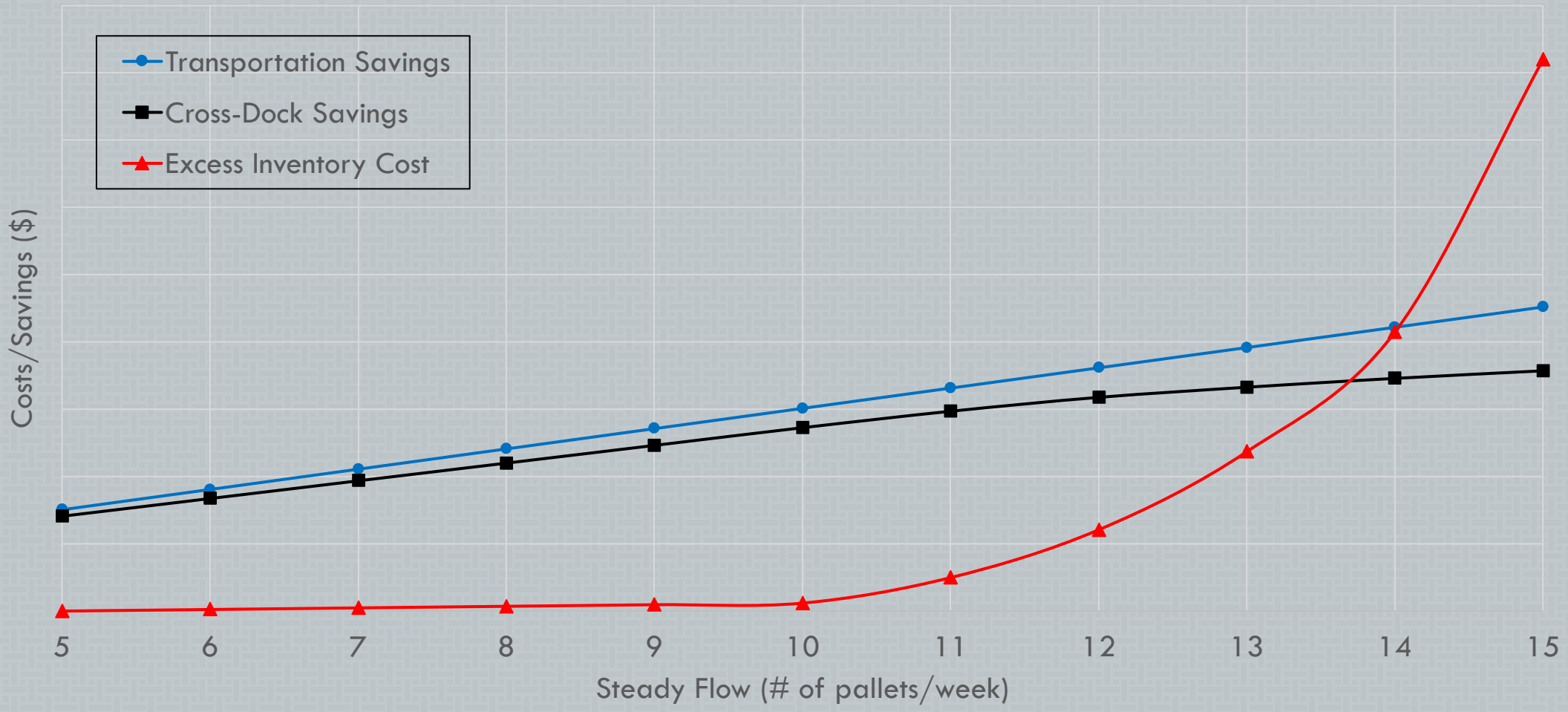

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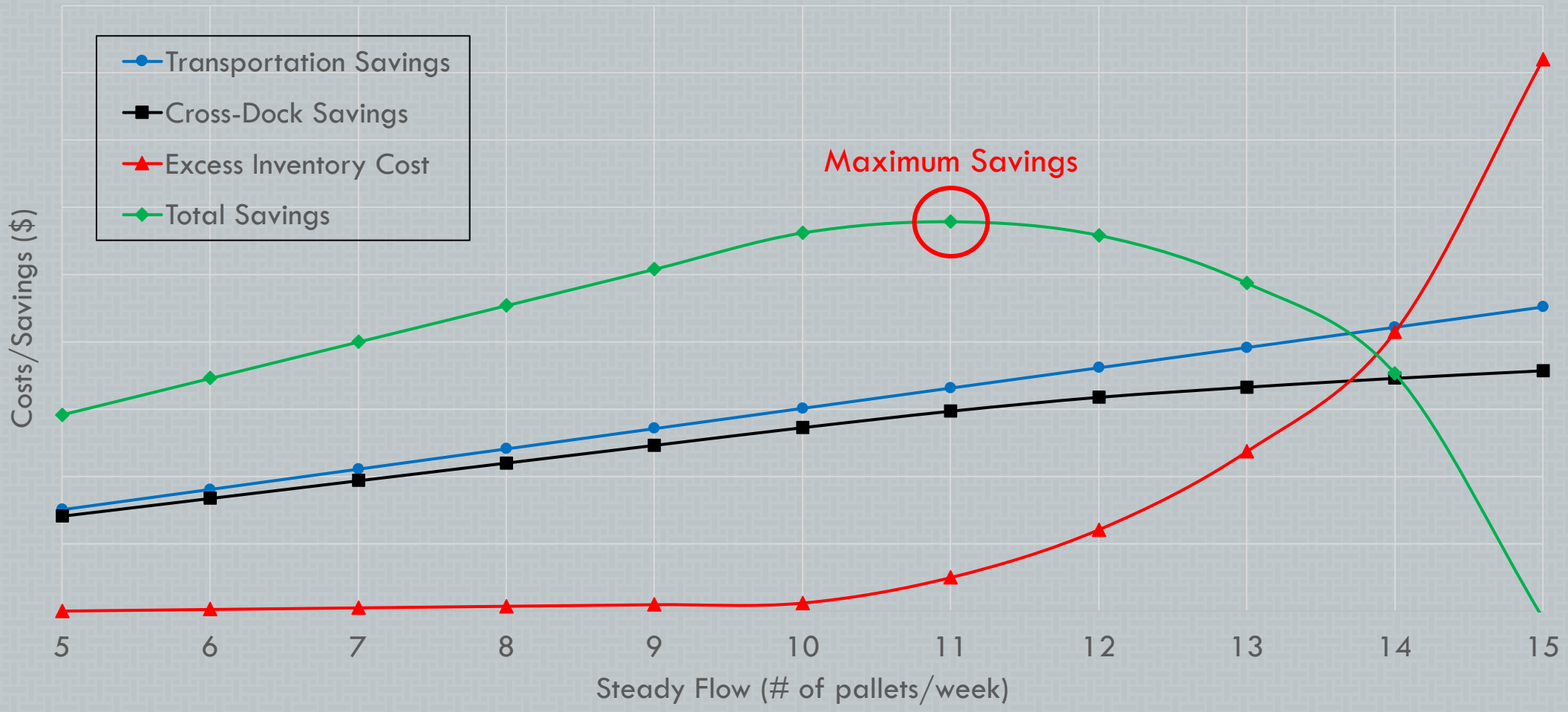
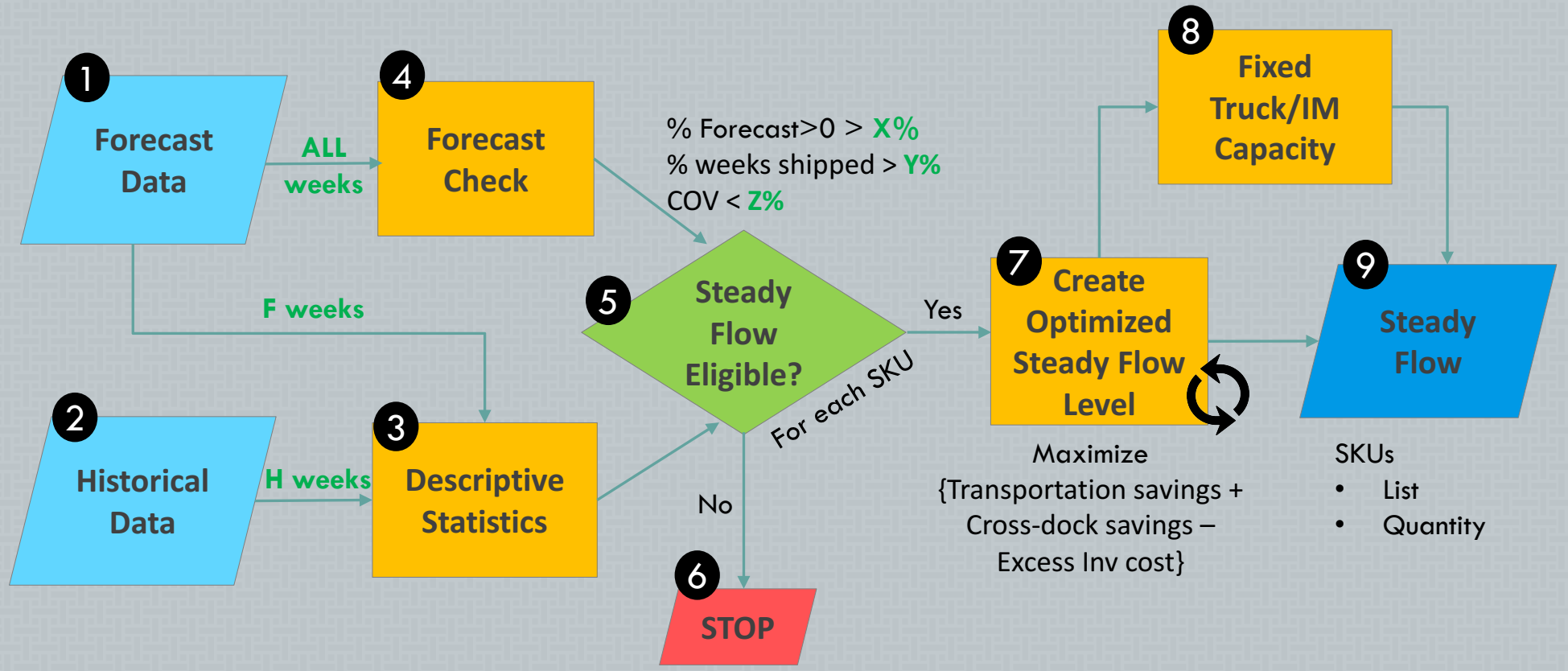


AGENDA

METHODOLOGY



STEADY FLOW OPTIMIZATION

Optimized Steady Flow Level = # of pallets for which the **Total Savings** are maximized

Total Savings = Transportation Savings + Cross-dock Savings - Excess Inventory Cost

For each SKU

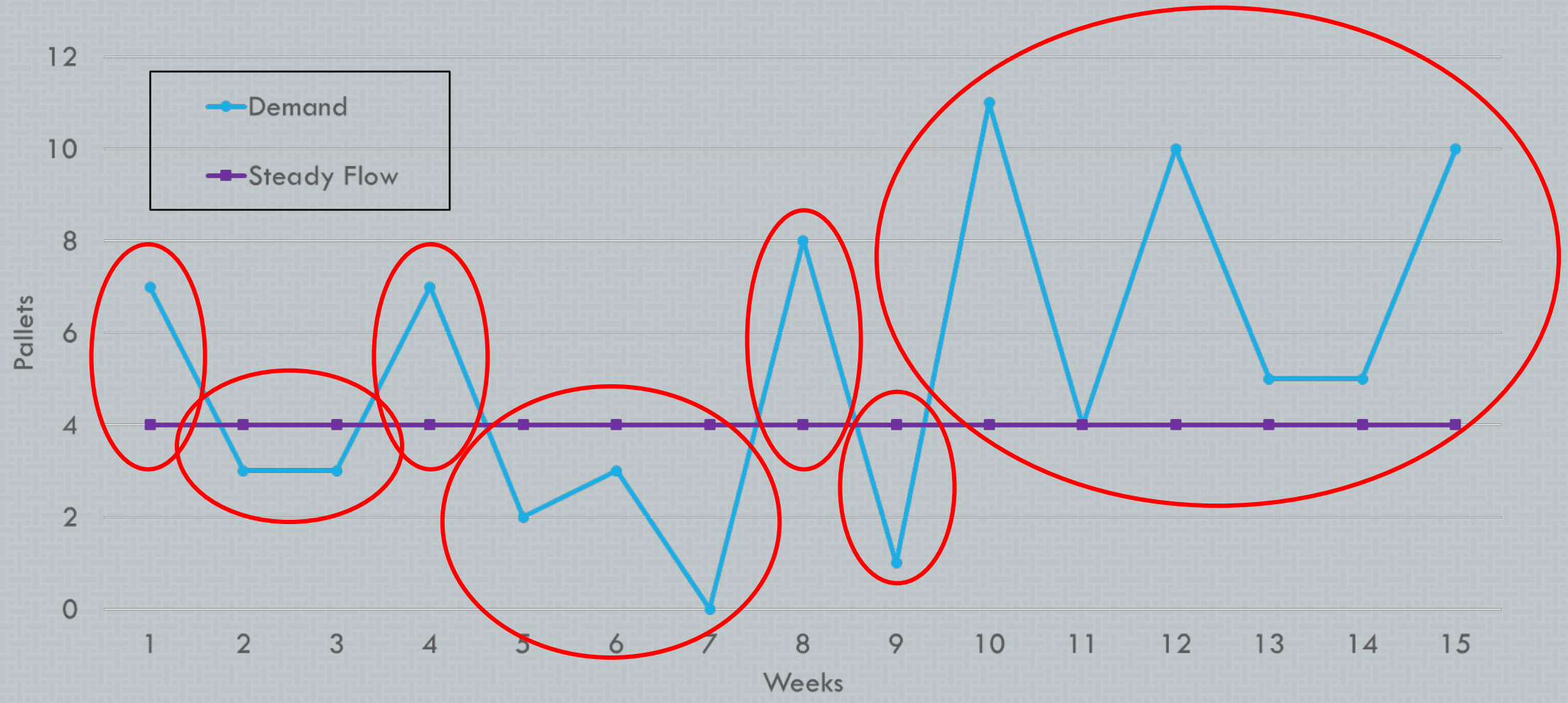
STEADY FLOW OPTIMIZATION

$$\text{Transportation Savings} = \sum_{\text{All periods}} \left\{ \left(\text{\# of pallets of Steady Flow}\right)\left[\frac{\text{Pallet}}{}\right] * \left(\text{\% of truck that a pallet represents}\right)\left[\frac{\text{Truck}}{\text{Pallet}}\right] * \left(\text{Transportation Savings per truck}\right)\left[\frac{\$}{\text{Truck}}\right] \right\}$$

$$Transportation\ Savings = \sum_{i=1}^{n} (\mathrm{s} * \mathrm{j} * \mathrm{p})$$

STEADY FLOW OPTIMIZATION

Cross-dock Savings Theory



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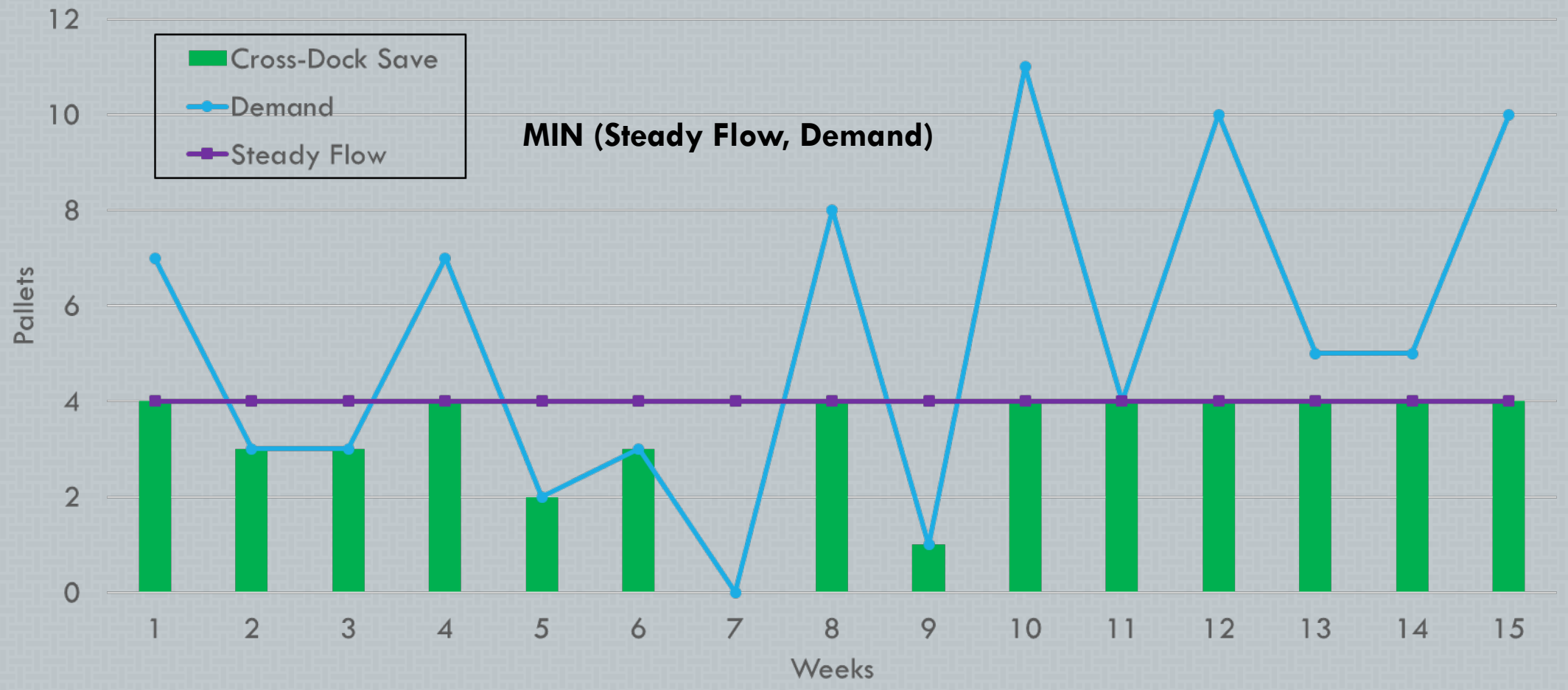


STEADY FLOW OPTIMIZATION

Cross-dock Savings $= \sum_{\text{All periods}} \{$ # of pallets that can be cross-docked $*$ Cross-dock savings per pallet $*$ Cross-dock eligibility $\}$

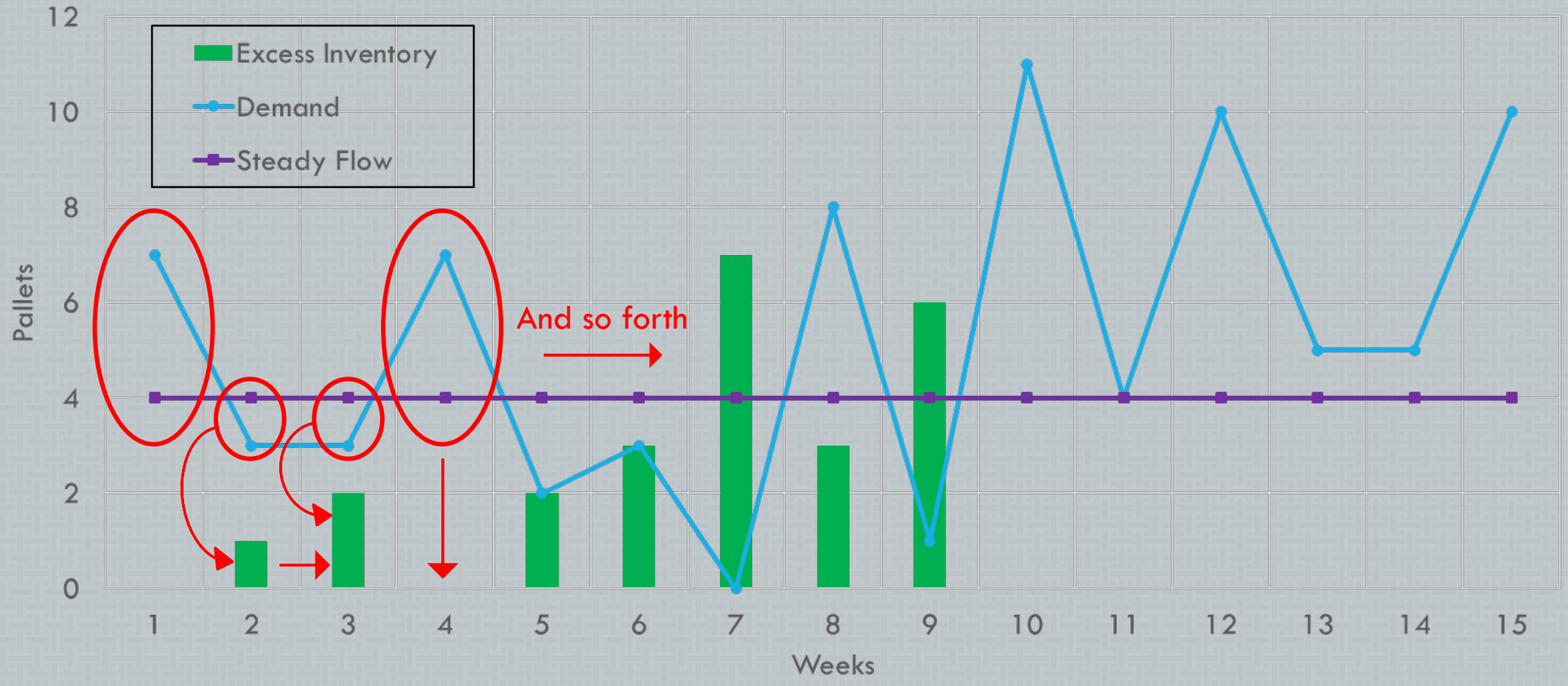
MIN (Steady Flow, Demand)

Pallet | $\frac{\$}{\text{Pallet}}$ | %

$$Crossdock\ Savings = \sum_{i=1}^{n} Min(s, d_i) * c_s * c_e$$

STEADY FLOW OPTIMIZATION

Excess Inventory Theory



STEADY FLOW OPTIMIZATION

$$\text{Excess Inventory Cost} = \sum_{\text{All periods}} \left\{ \left(\underset{\frac{\text{Pallet}}{}}{\text{Excess pallets from previous period}} + \underset{\frac{\text{Pallet}}{}}{\text{Excess pallets from current period}} \right) * \underset{\frac{\text{Truck}}{\text{Pallet}}}{\text{\% of truck that a pallet represents}} * \underset{\%}{\text{Inventory holding cost per truck per week}} * \underset{\frac{\$}{\text{Truck}}}{\text{Inventory value per truck per week}} \right\}$$

$$+ \left\{ \underset{\frac{\text{Pallet}}{}}{\text{Pallets left at the end of the period}} * \underset{\frac{\text{Truck}}{\text{Pallet}}}{\text{\% of truck that a pallet represents}} * \underset{\frac{\$}{\text{Truck}}}{\text{End of period penalty}} * \underset{\%}{\text{Risk factor}} \right\}$$

$$Excess\ Inventory\ Cost = \left\{ \sum_{i=1}^{n} \text{Max}((e_{i-1} + s - d_i), 0) * j * h * v \right\} + \{\text{Max}((e_{n-1} + s - d_n), 0) * j * v * r\}$$

STEADY FLOW OPTIMIZATION

$$Total\ Savings = Transportation\ Savings + Crossdock\ Savings - Excess\ Inventory\ Cost$$

Objective Function*: *MAXIMIZE Total Savings

***Decision Variable*: # *of pallets on steady flow* (s)**

$$Transportation\ Savings = \sum_{i=1}^{n} (\mathrm{s} * \mathrm{j} * \mathrm{p})$$

$$Crossdock\ Savings = \sum_{i=1}^{n} Min(s, d_i) * c_s * c_e$$

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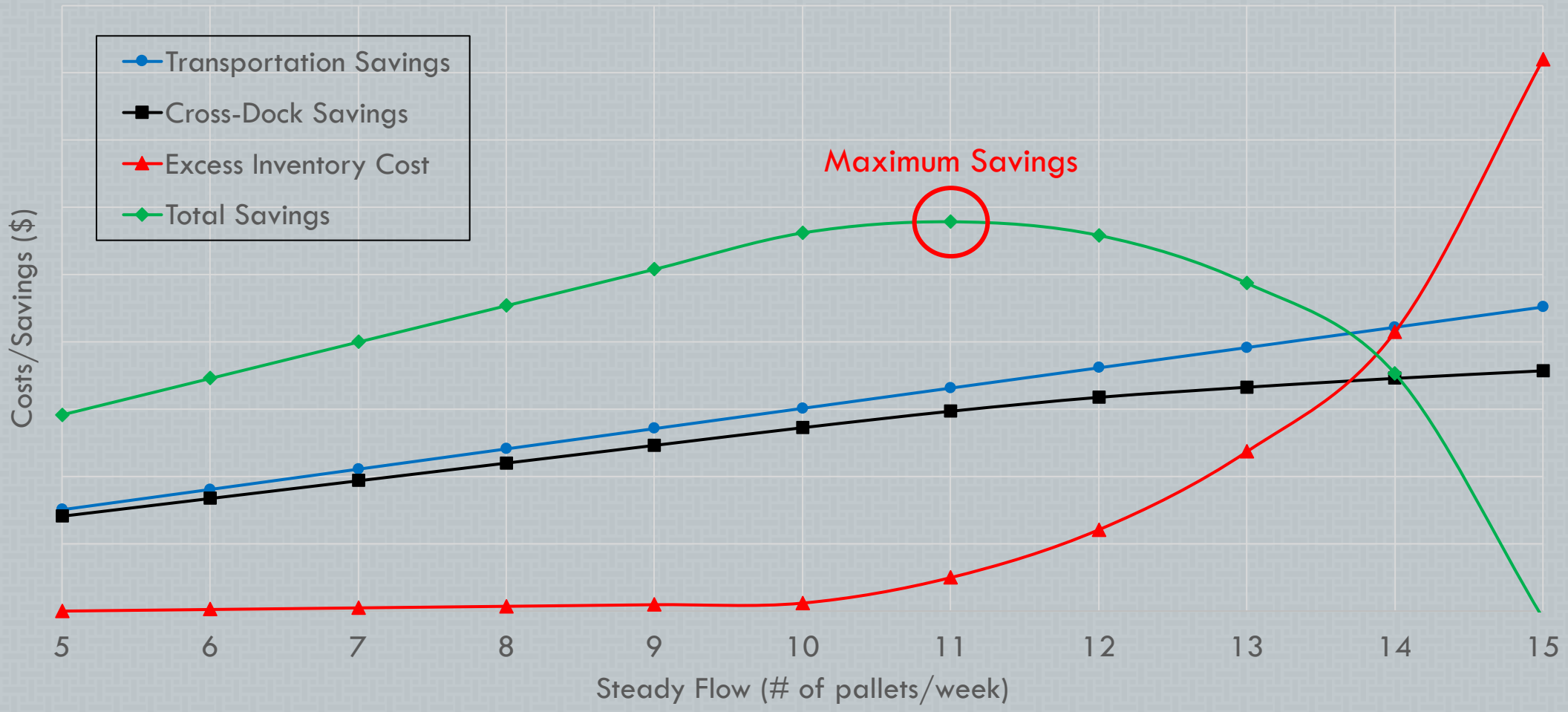
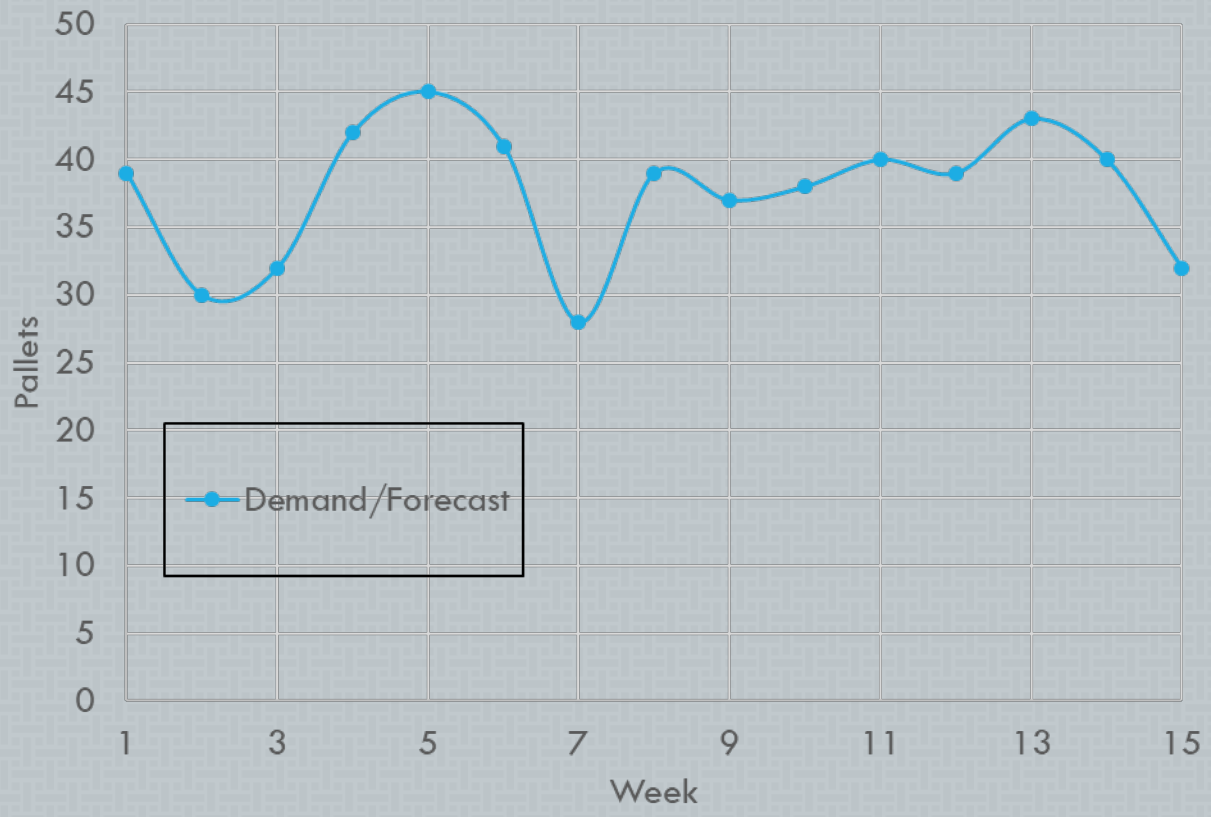


AGENDA

SKU EXAMPLE 1

Demand Characteristics			
Minimum (pallets/week)	28	% weeks shipped	100%
Mean (pallets/week)	37.7	COV	0.13
Std Dev (pallets/week)	4.80		
Moderate Volume, Stable SKU			



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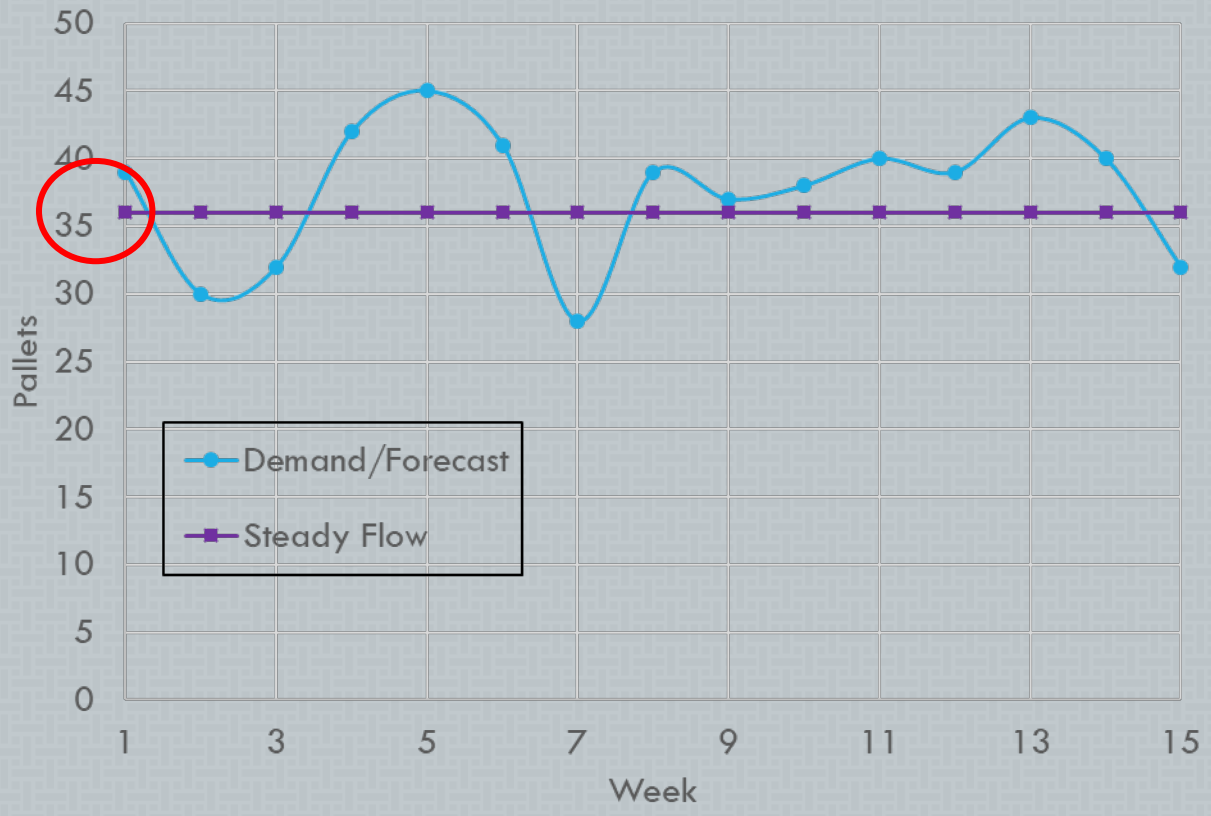
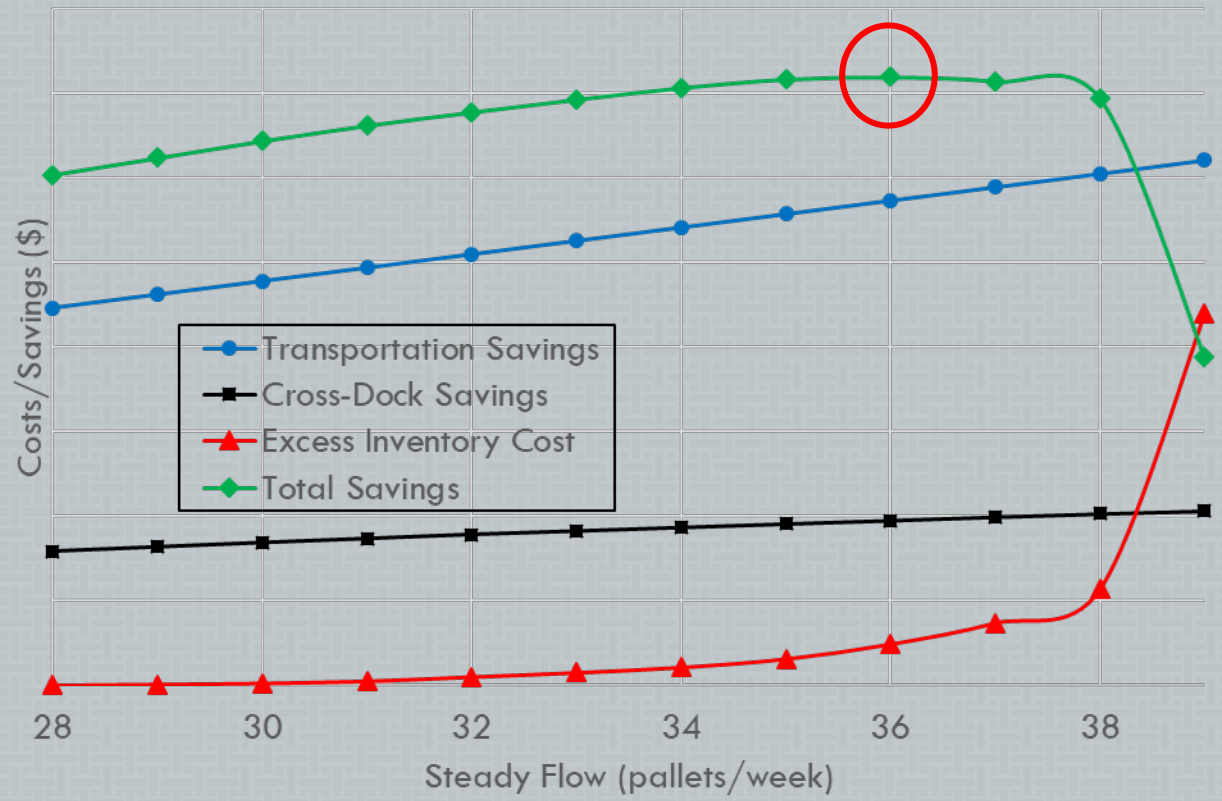
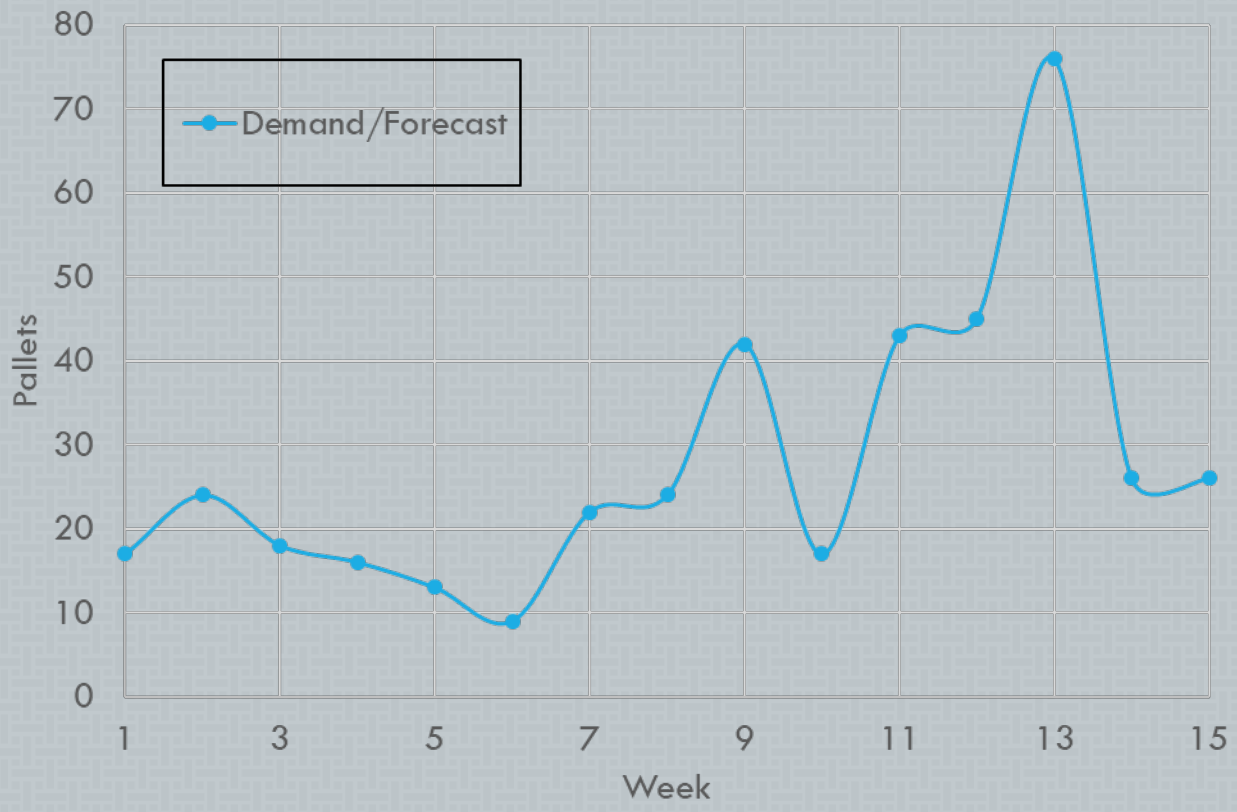




SKU EXAMPLE 2

Demand Characteristics			
Minimum (pallets/week)	9	% weeks shipped	100%
Mean (pallets/week)	27.9	COV	0.60
Std Dev (pallets/week)	16.7		
High COV SKU			



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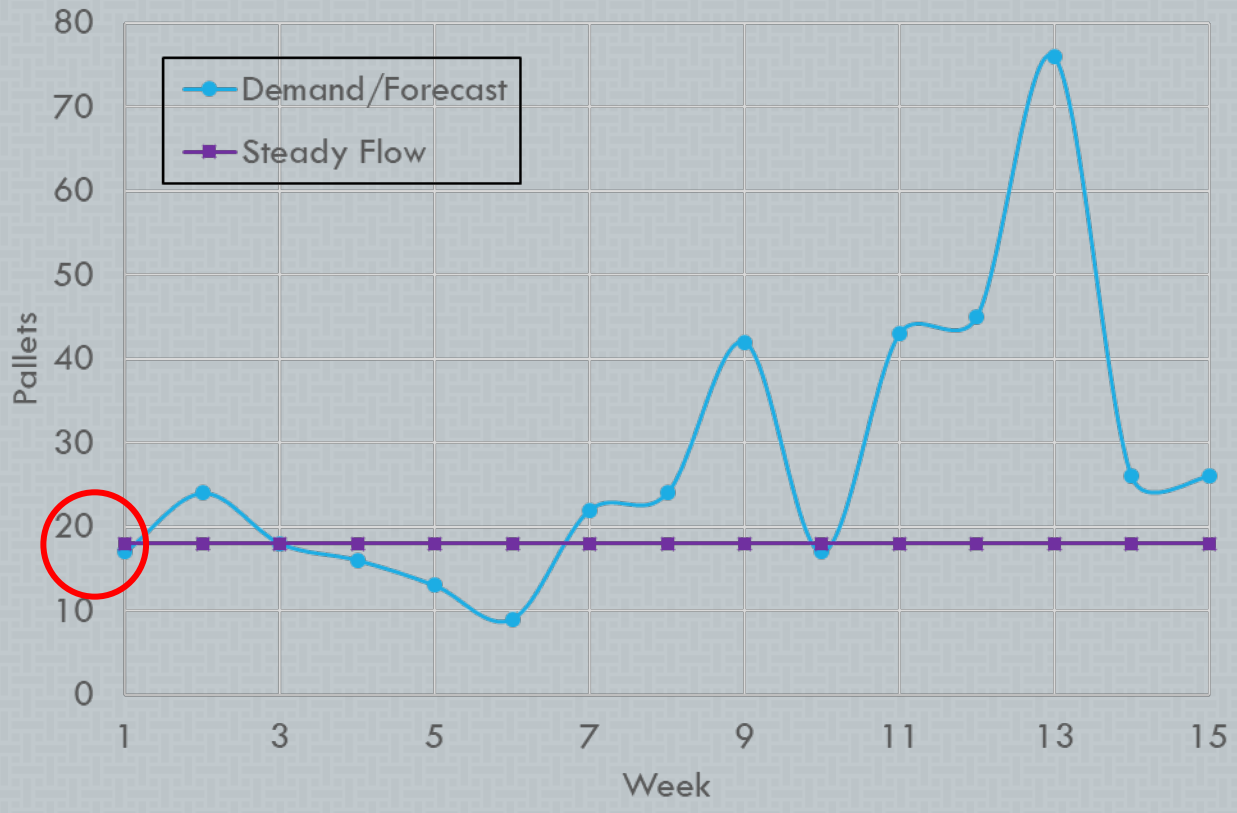
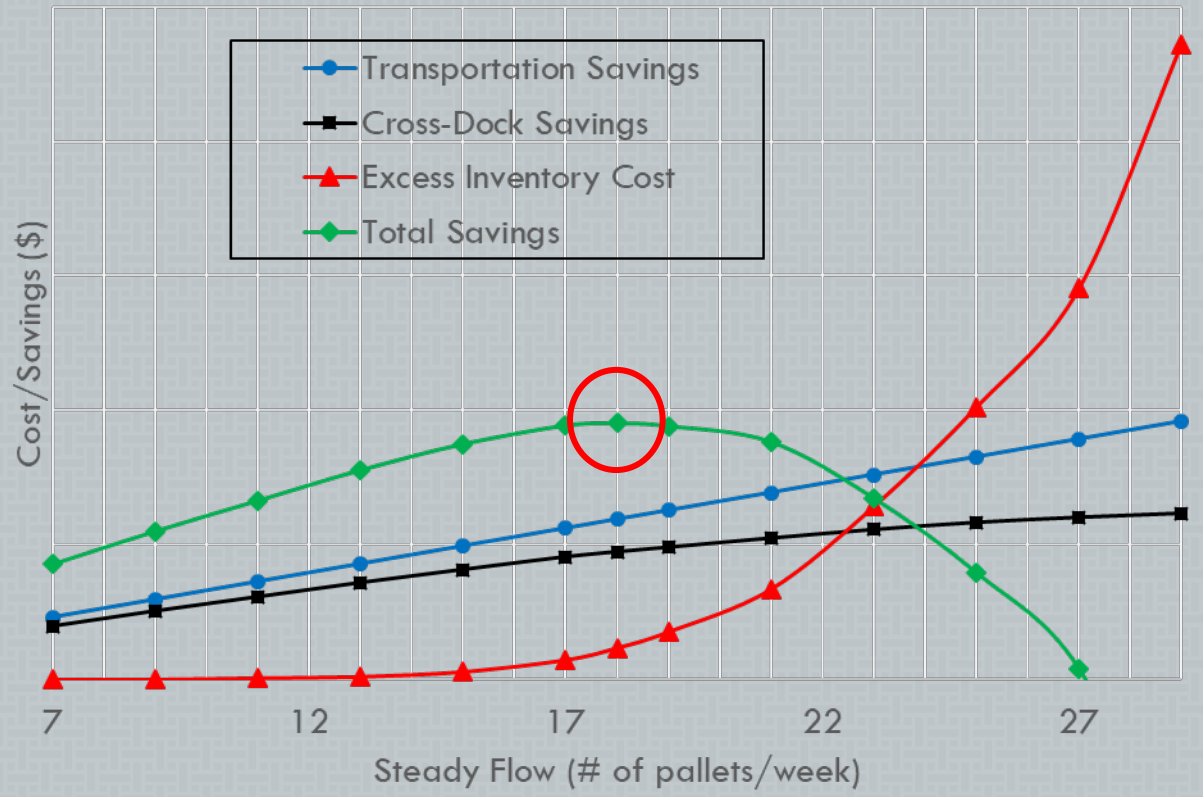
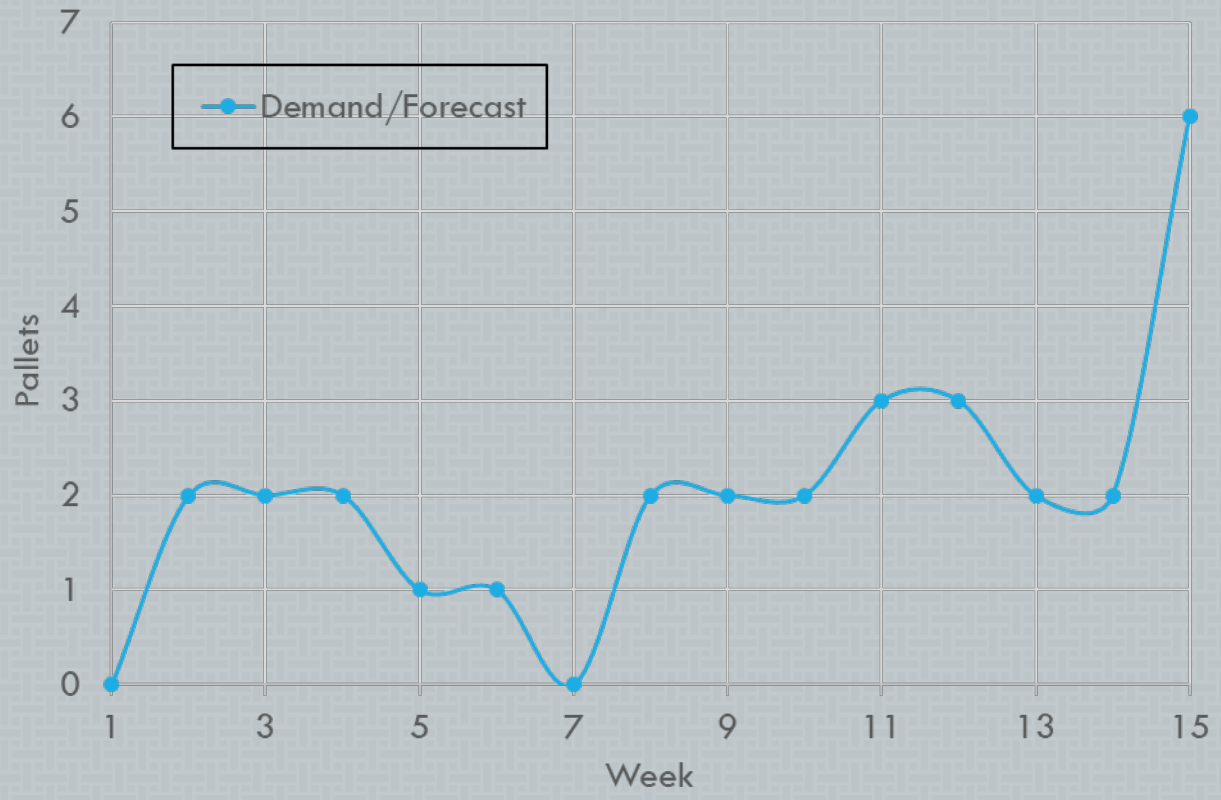




SKU EXAMPLE 3

Demand Characteristics			
Minimum (pallets/week)	1	% weeks shipped	87%
Mean (pallets/week)	2.3	COV	0.52
Std Dev (pallets/week)	1.20		
Low Volume, Not Shipped Every Week			



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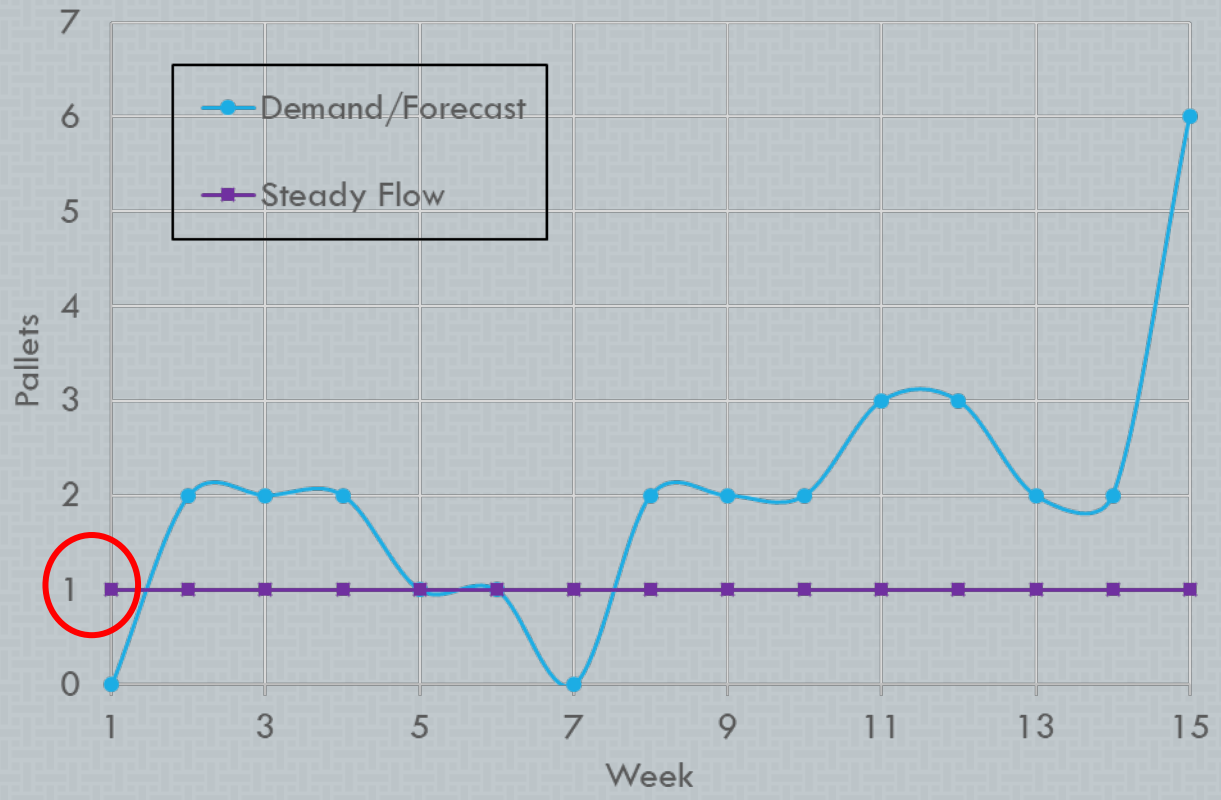
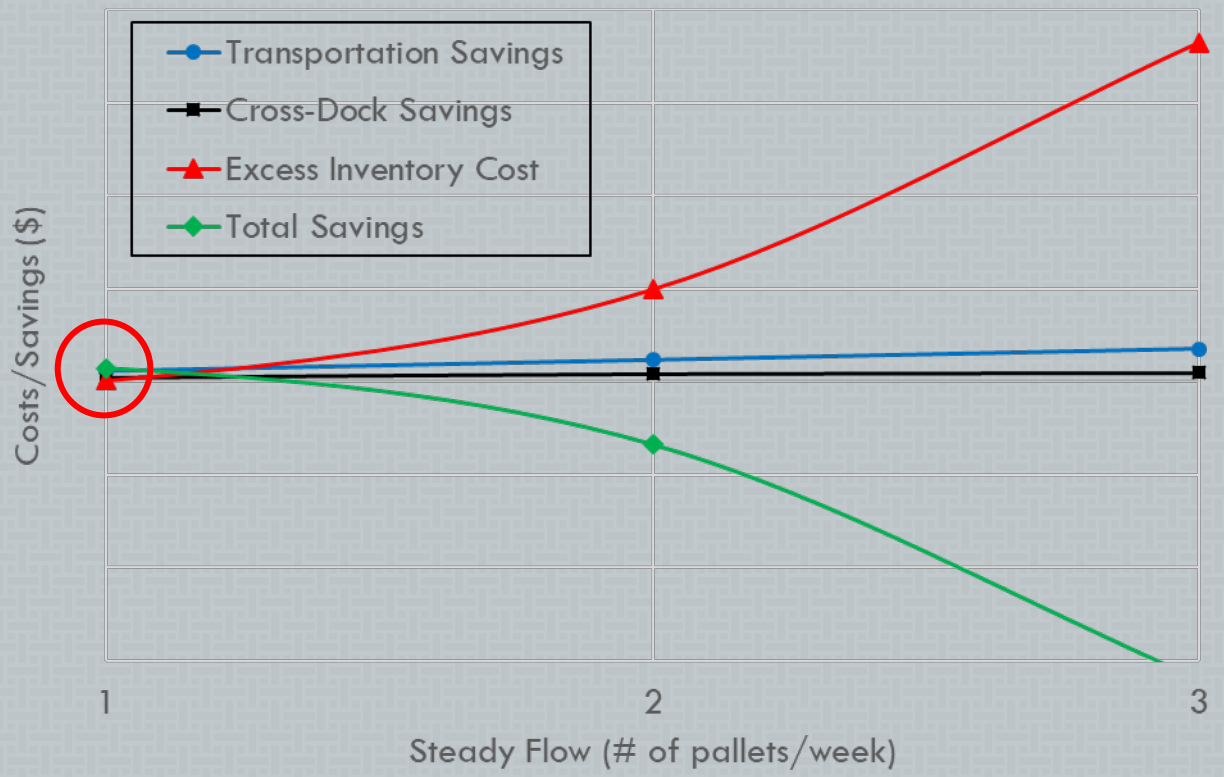
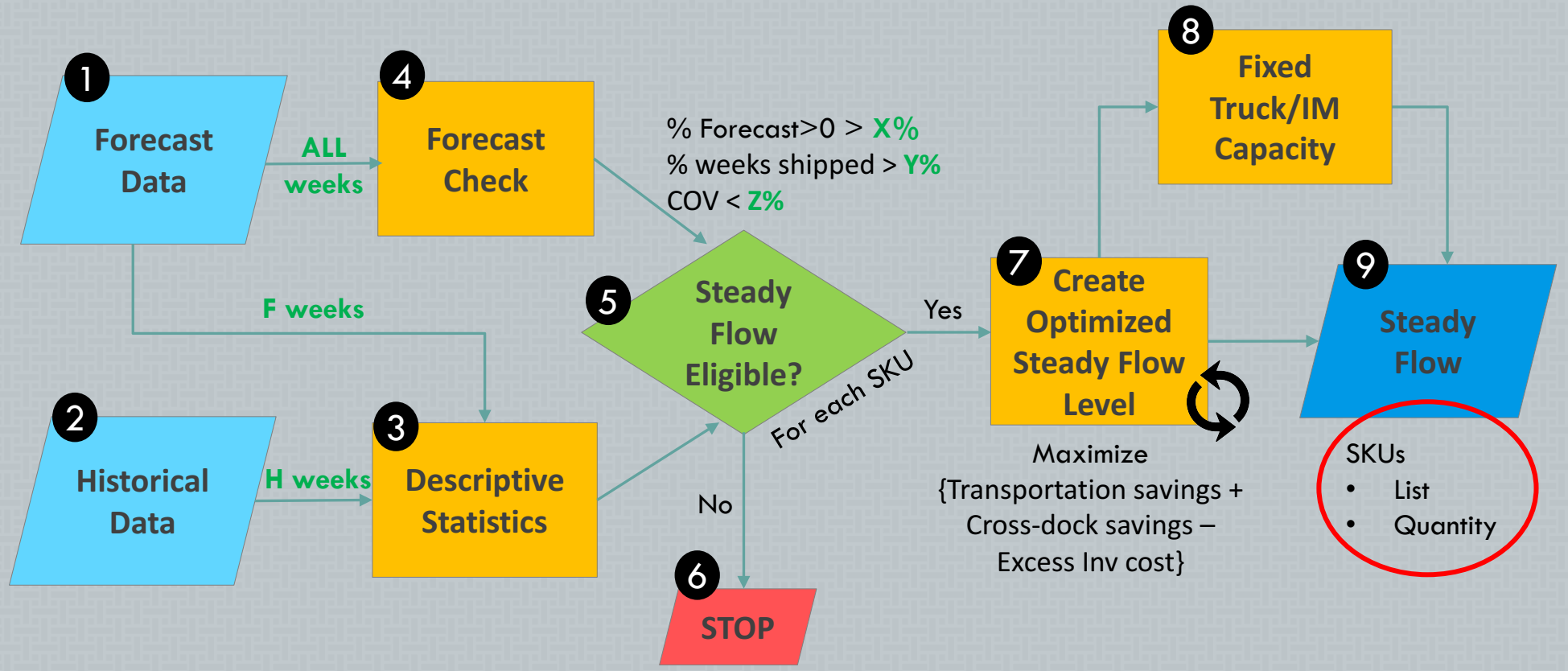




FINAL OUTPUT



AGENDA

Project Overview

Methodology

Model Output

Next Steps

NEXT STEPS

Model Enhancements

- ❑ Data Aggregation
- ❑ Other Savings/Cost Considerations
- ❑ SKU Selection

Analysis

- ❑ Parameter Tuning
- ❑ Multiple Lane Analysis
- ❑ Demand Segmentation

Processes

- ❑ Update Frequency
- ❑ Contract Innovation
- ❑ Distribution Resource Planning (DRP)

IMPLICATIONS

THANK YOU!