Impact of Technology Failures

Electronic Prescribing & User Behavior

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Electronic Prescriptions: Context & Timeline

Adoption of eRx begins

- **2003** : eRx took off with the Medicare Modernization act
- About **22% of the physicians** were using e-Rx

HITECH Act

- Incentive program established by the Health Information Technology for Economic and Clinical Health for adoption of eRx

Low adoption rates

- **2010 : 36 %** adoption rate despite the proven benefits
- **2013 :** Half decade post HITECH Act, adoption rate is only **54%**

Why the low rates?

- unreliable connectivity between prescribers and pharmacies
- deployment cost, workflow concerns, perceived value, end-user constraints, organizational culture, and technology reliability and capability

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HOWEVER! too little is documented about the **impact of technology failures** on adoption and continued use to draw this industry's attention.

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Case: An actual eRx transmission & communication failure resulted in subsequent technology de-adoption in the ambulatory care setting

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PITTSBURGH REGIONAL HEALTH INITIATIVE

Spreading Quality, Containing Costs.

Why this topic?

- Interesting application of SPC in healthcare setting
- How will a process monitoring approach look like?
- Can we flag/mitigate the negative impacts of technology failures by monitoring time series data

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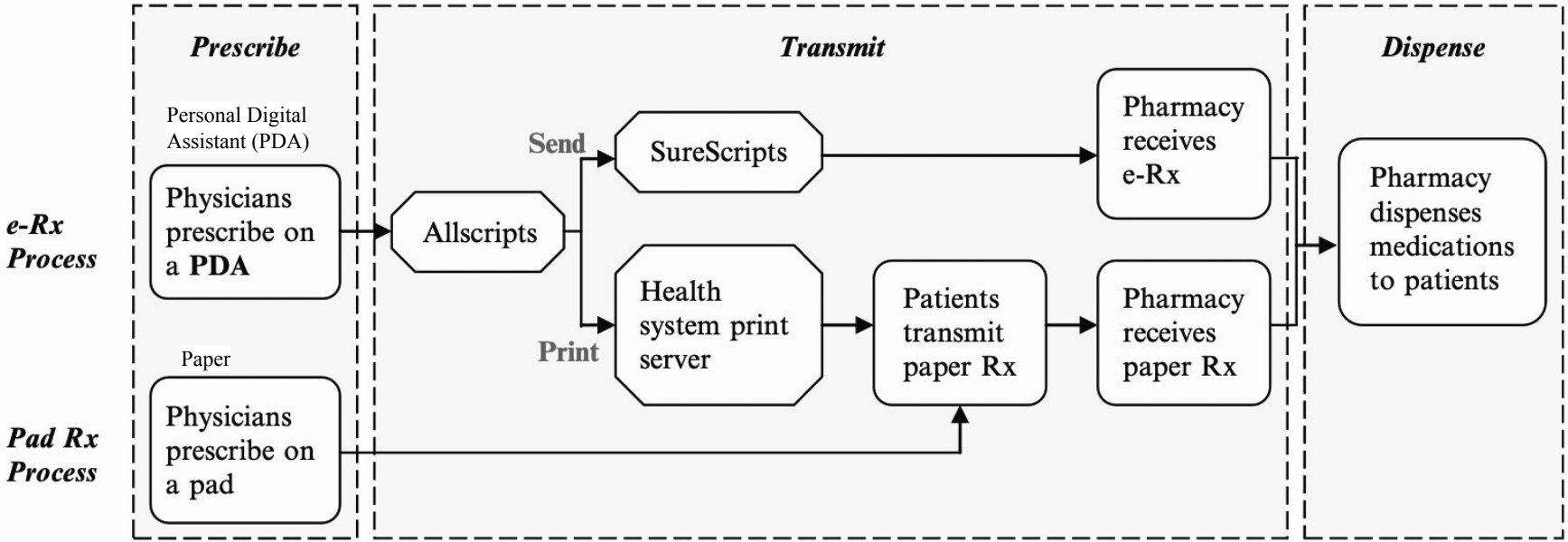
This Case - Storytime!

Based on two primary care practices affiliated with a major medical centre in the Greater Pittsburgh Region

Incident	Failure Event	Effect
Fall 2006 Series of patient complaints about trouble getting their prescriptions filled @pharmacy because their prescriptions were “missing”	Server error at Pharmacy A caused the transmission error No confirmed failure reports however Physicians continue to submit e-prescriptions	Complaints piled up and gradually physicians switched to either printing or writing Rx 11 % additional revenue normally generated by e-Rx lost at other pharmacies

Prescribing Workflow

Retrospective Break Point Analysis



Generating Rx → **Paper Rx** **PDA + Print** **PDA + Transmit to pharmacy**

Feature Engineering + Preprocessing Data!

36K data points
Each instance is a prescription
Removed redundancies & duplicates

Aggregated the pharmacy categories
91 → 5
four largest chain pharmacies (A, B, C, D & other)

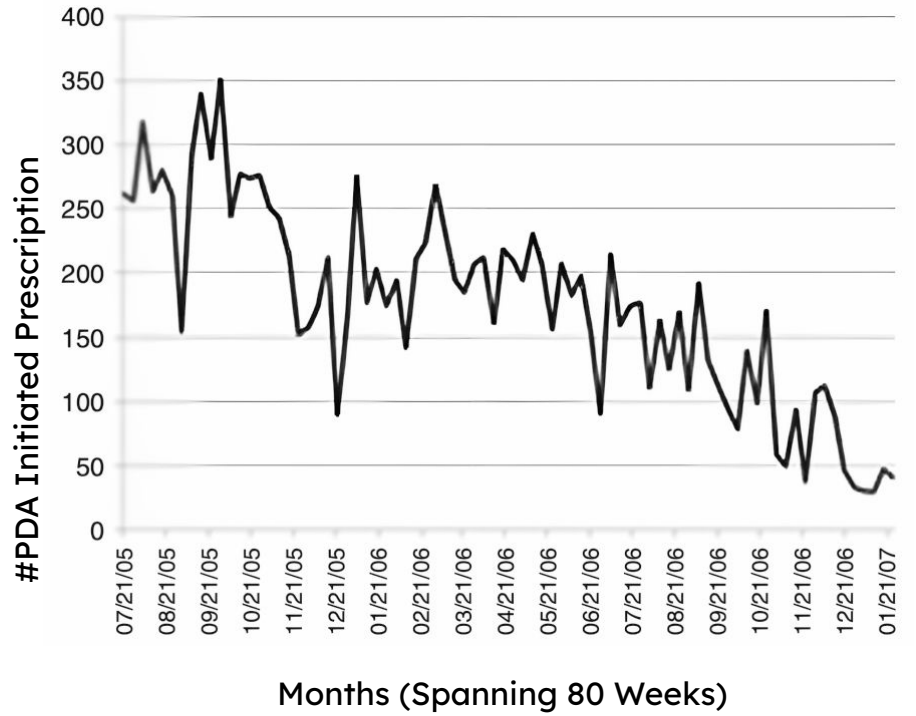
Aggregated the **daily prescription counts to weekly counts** → Easier for analysis

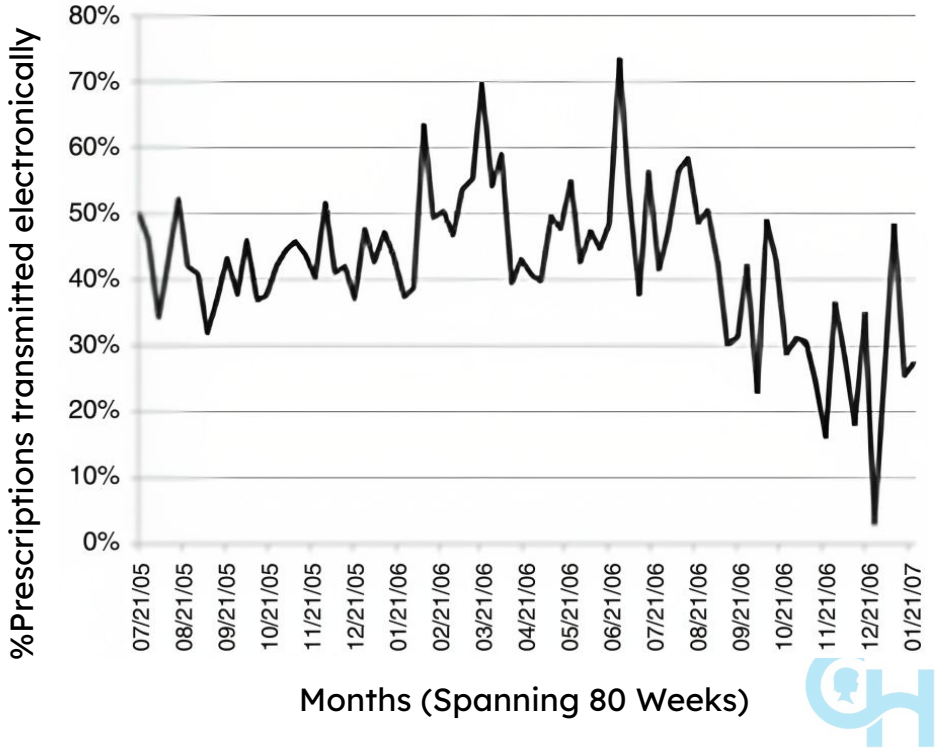
Finally! **14K E-rx** written by 6 physicians at 2 locations using the PDA over **80 weeks, from July 21, 2005 to January 31, 2007**

Data Set Features

- Drug ID
- Drug name
- Prescription date
- De-identified physician ID
- whether the prescription originated on a PC or PDA,
- whether the prescription was sent electronically or printed
- Destination Pharmacy ID

No. of eRx & proportion of eRx electronically sent to pharmacies over 80 weeks



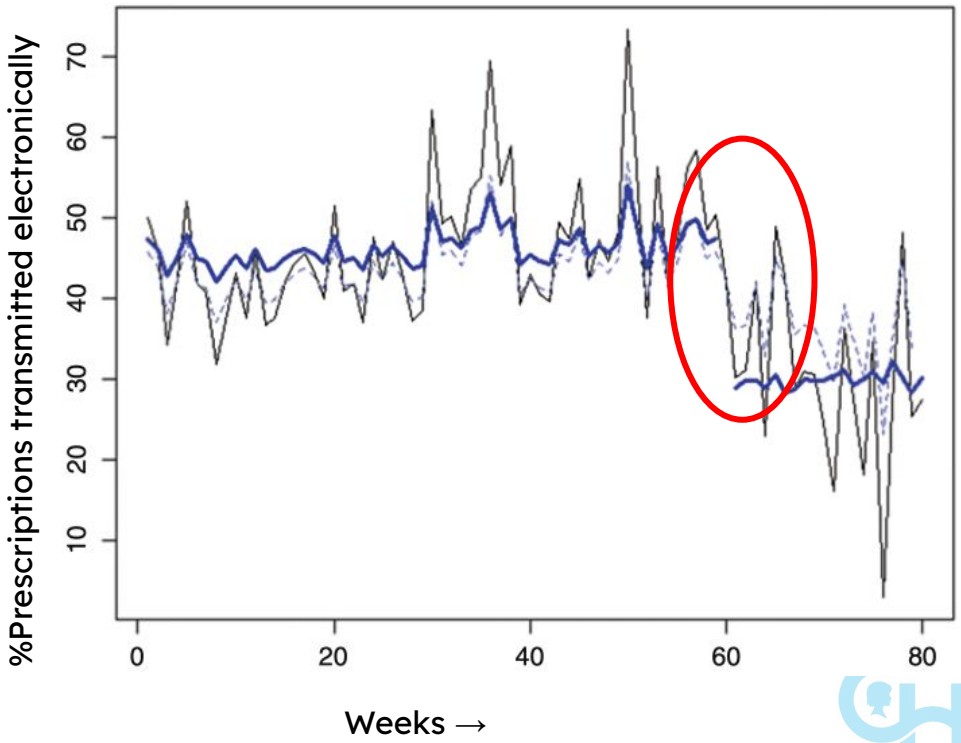


Identifying System Break Points
using Statistical Analysis & Time Series

Legend: ---- *Inhouse estimates*
Observed values
Bai Perron's BreakPoints

Single break point in %Send time series
Week 61: September 14, 2006

Proportion of the eRx transmitted electronically reached a high of 50 % prior to the failure, but dropped to less than 30 % after September 14, 2006.



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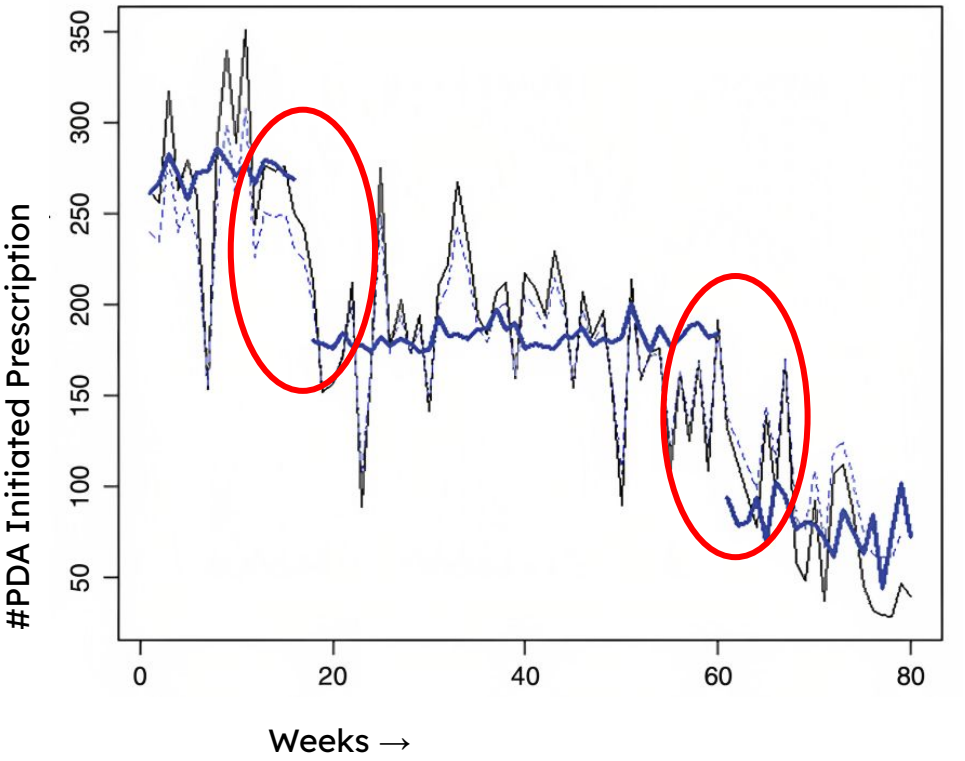


Legend: *Inhouse estimates*
Observed values
Bai Perron's BreakPoints

Two break points in #PDA time series
Week 18 (November 17, 2005)
Week 61 (September 14, 2006)

Beginning	Fall 2005	Sept. 2006
275/week →	180/Week →	80/Week

Using Control Charts to detect out of control events in User Behaviour

Post Breakpoint

In Control Process : Data from March 9, 2006 to September 13, 2006, a 6-month period prior to the breakpoint

CUSUM charts to **detects abnormal value 3 SD** away from the target mean.

Probability of Type I error : **0.01**

Residual-based control chart : #PDA and %Send are both serially correlated & violate the independence assumption of CUSUM chart. Therefore, estimates available in dataset were used.

Target means (of residuals)

- **5.14 % for %Send**
- **15.74 for #PD.**

Using Control Charts
Frame of thought + methodology

Why CUSUM?

More sensitivity to detection by accumulating deviations prior to the evaluated break point

Why V-Mask?

Easily identifies significant deviations from the target mean

Easily identifies out-of- control

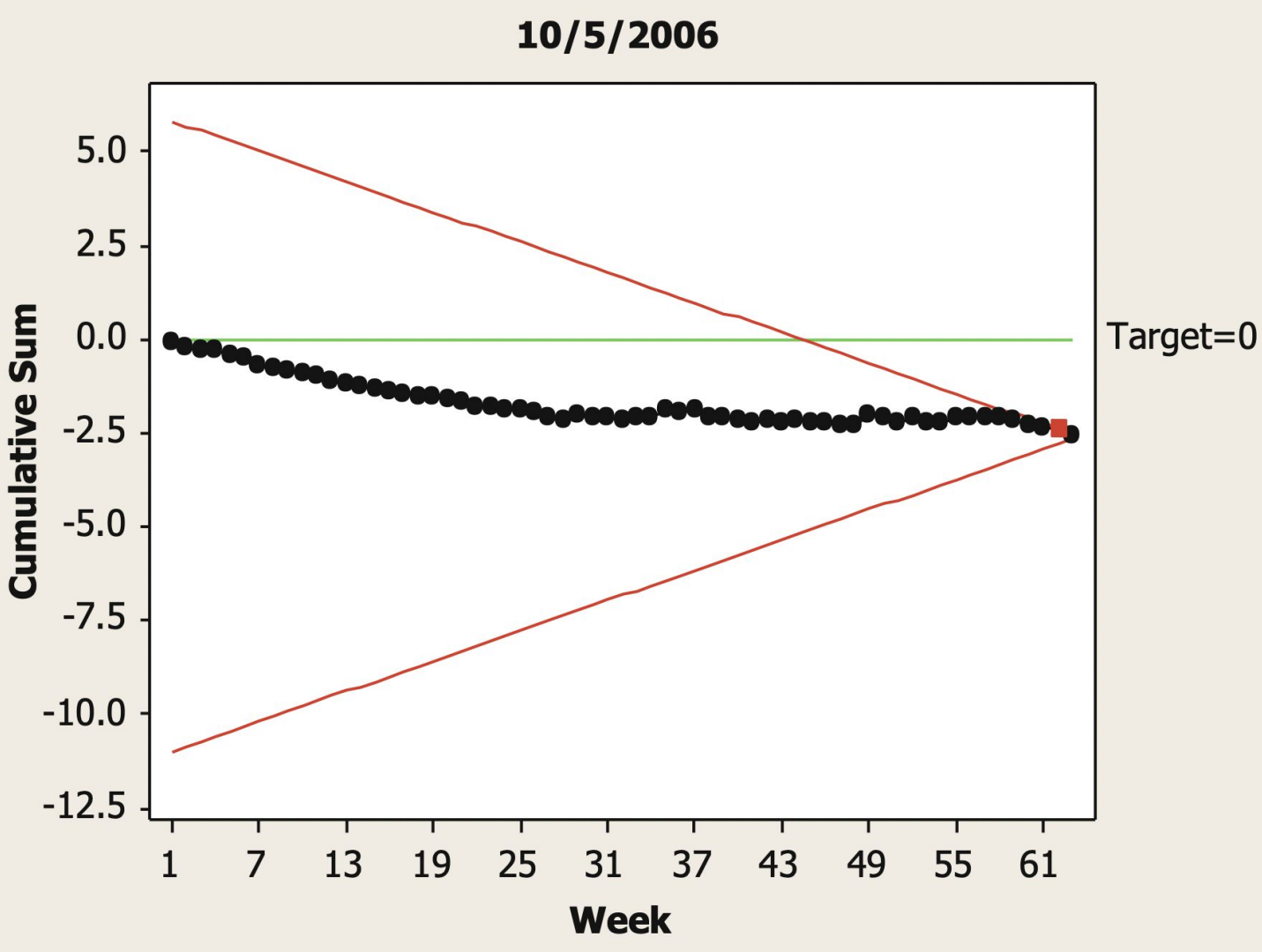
Shifts within 3SD are permissible, however this can be easily varied.

Why Bai & Perron's Model ?

To identify breakpoints or change points in a time series data set

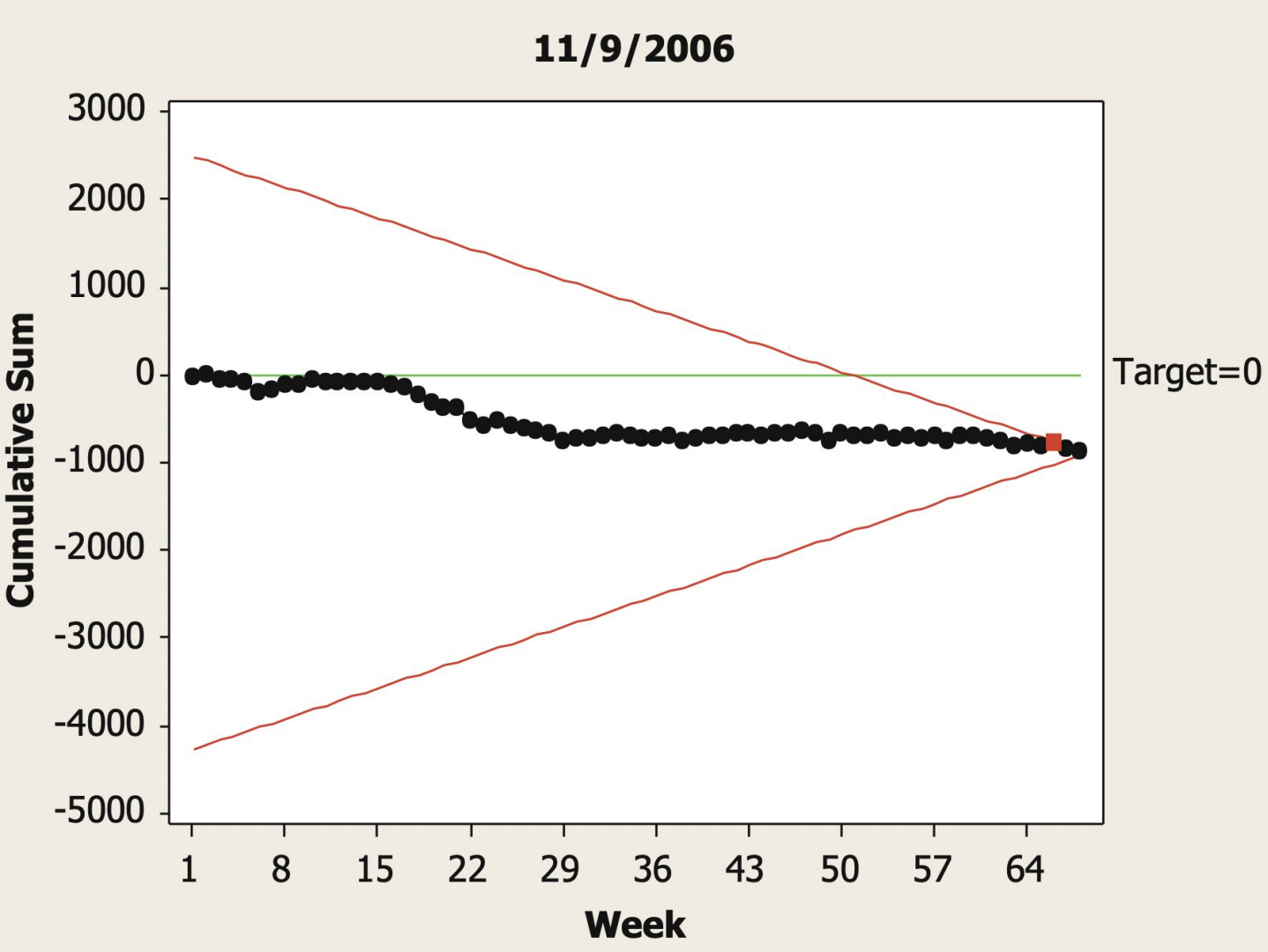
Particularly useful in detecting **multiple breakpoints** in linear regression

When only some of the coefficients are subject to shifts.



The first out-of-control event in %Send series was **Week 64 (October 5, 2006).**

I also found more alerts between November 23, 2006 and January 18, 2007 (excluded as they were not in scope of this study)



The only
out-of-control event in
#PDA series was in
Week 69
(November 9, 2006)

Using Control Charts to tell a story

Case Overview

Week of October 5, 2006 : the physicians switched to printing prescriptions

- no way to confirm if problem occurred
- “Safer” to print Rx

Week of November 9, 2006 : physicians’ faith in e-prescribing collapses

- they stopped using the PDA/ eRx
- patient safety is potentially jeopardized
- pharmacies’ revenue likely decreased

Summary Insights + Conclusions

e-Rx vendors can employ control charts, such as CUSUM

- to monitor and quickly detect abnormal patterns
- detect downward trends of #PDA and %Send
- prescribe action plans to mitigate the effects

Statistical process control charts: - prevent the breakdowns from impacting operations significantly through quick identification

Value Proposition

- IT adoption can eventually become sustainable
- Technology deployment will be more **robust and reliable**

Thank you!

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