



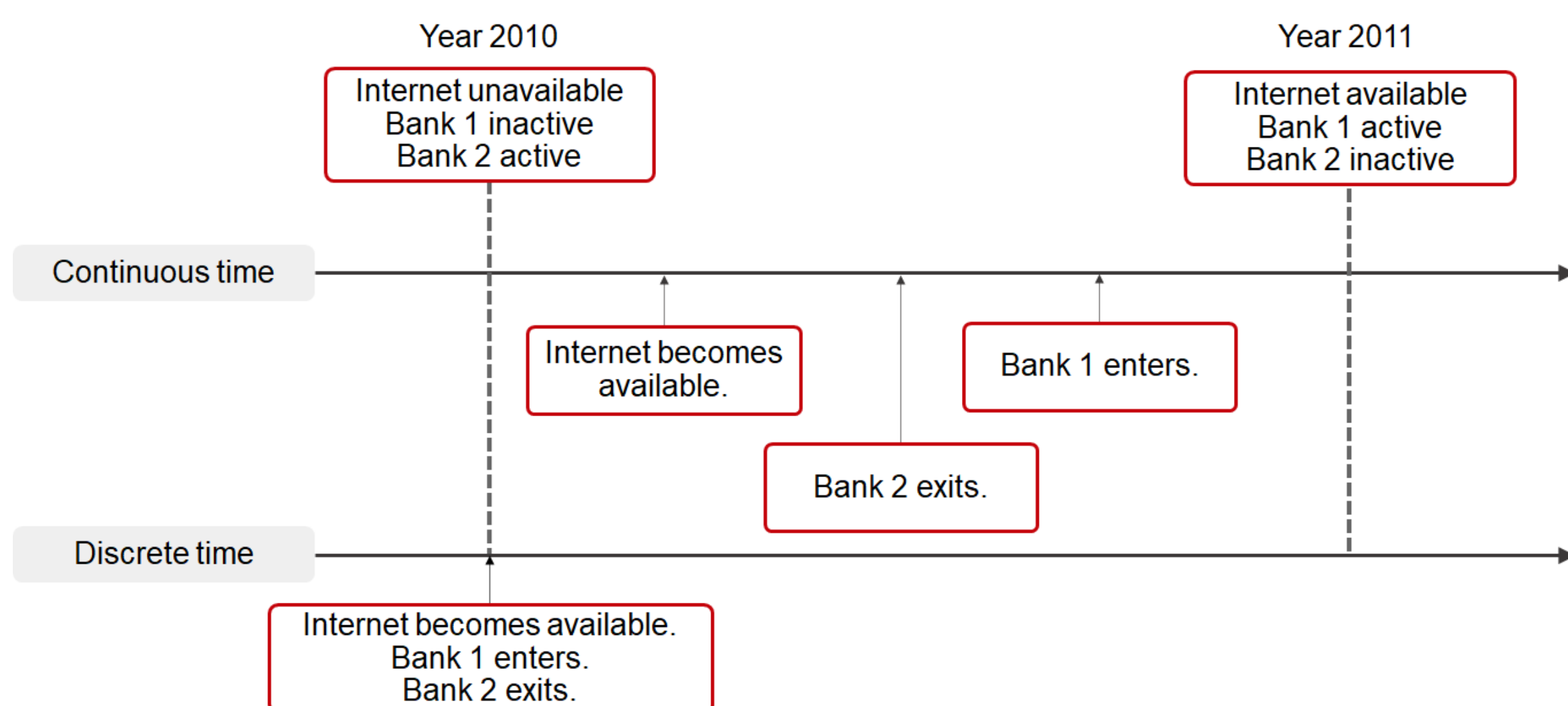
## Goal

This paper examines the effect of the internet on bank branch profits by estimating a dynamic discrete game in continuous time and a demand model for deposits.

## Motivation

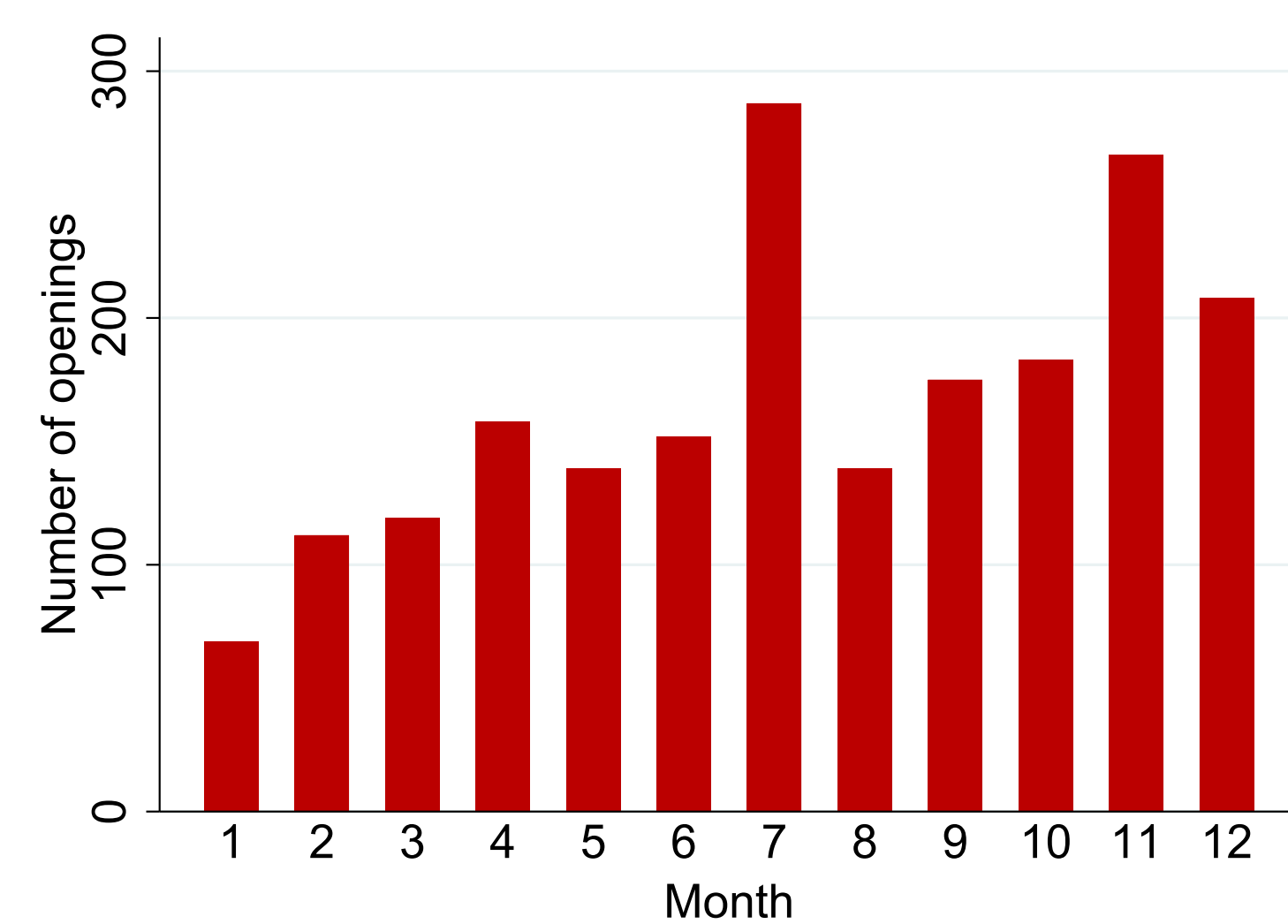
- Motivation 1 (Online banking and bank branch closures)** Banks are closing brick-and-mortar bank branches to decrease costs but consumers keep visiting branches (Reuters, 2016). Then, do consumers still need bank branches?
  - 40% of low-income banked families chose the bank teller as their primary method to access bank accounts (FDIC, 2018).
  - Bank branch closings have large negative effects on credit supply to local small businesses (Nguyen, 2019).
- Motivation 2 (Continuous time)**: Continuous time models allow asynchronous moves of state variables whereas discrete time models assume every event happens simultaneously at the beginning of the data period.
  - Example (Figure 1): In continuous time, the sequence of events imply that Bank 2 left the market because the internet was introduced in the market, but it is difficult to find out the reason for Firm 2's exit in a discrete time setting.

Figure 1: Difference between continuous time and discrete time



– The number of branch openings each month shows that stochastic decision times are likely to represent a closer approximation to reality.

Figure 2: The number of bank branch openings by month



Note: Wells Fargo/BoA/Chase/US Bank/PNC branches opened in 2010–2016.

– If the data was generated in continuous time but a discrete time model is estimated, the biases will be large (Blevins and Kim, 2019).

## Expected effects of the internet on branch profits

- When brick-and-mortar retail chains add online channels, there can be two effects (Duch-Brown et al., 2015)
  1. **Market expansion effect**: Online channel can induce new customers by reducing transportation costs and search costs.
  2. **Sales diversion effect**: Consumers switch from traditional channel to online.
- Which effect is larger in banking industry adding online banking channel?

## Data

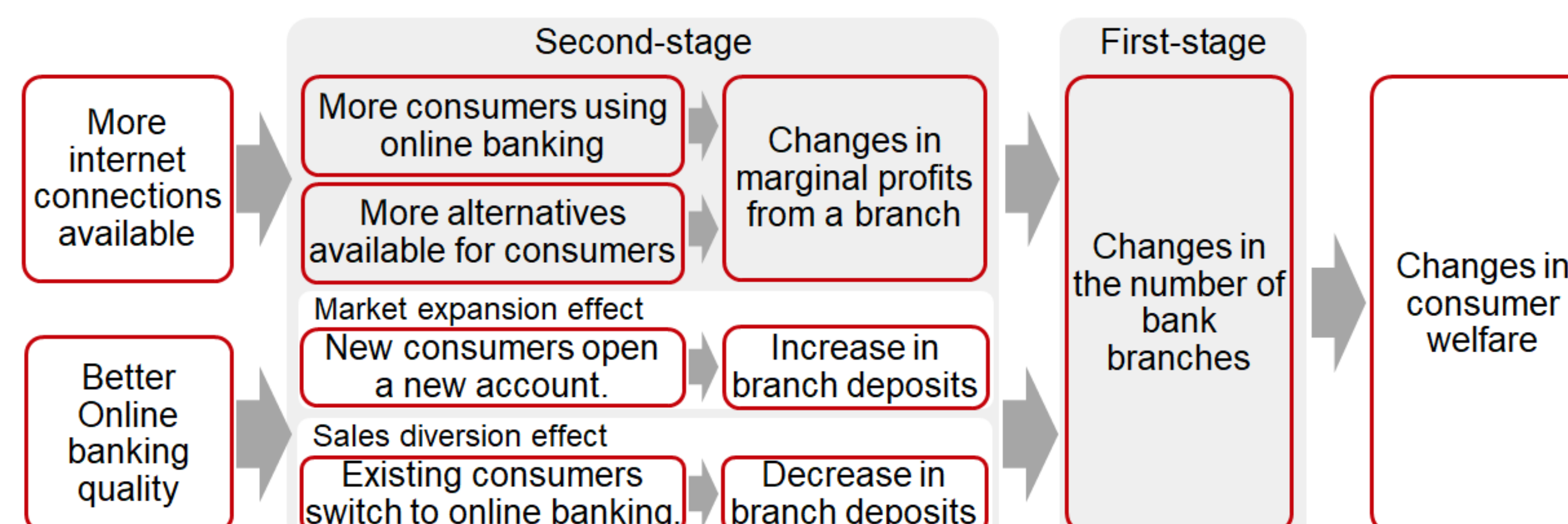
- Market definition: U.S. Counties with population less than 250,000
- Banks included in the model: Five largest banks by branches in 2010–2016 (Wells Fargo, JPMorgan Chase, Bank of America, US Bank, PNC Bank)
- Internet: Federal Communications Commission (FCC) assigns the index of 1~5 according to the number of residential internet connections per 1,000 households.
- Online banking quality: Proxied by website traffic to each bank's website.

## Two-stage Model

- Banks open and close branches based on expectation on marginal profits from branches in the first stage and consumers choose a bank to make deposits and banks decide the deposit rate in the second stage (Ishii, 2008; Kuehn, 2018).

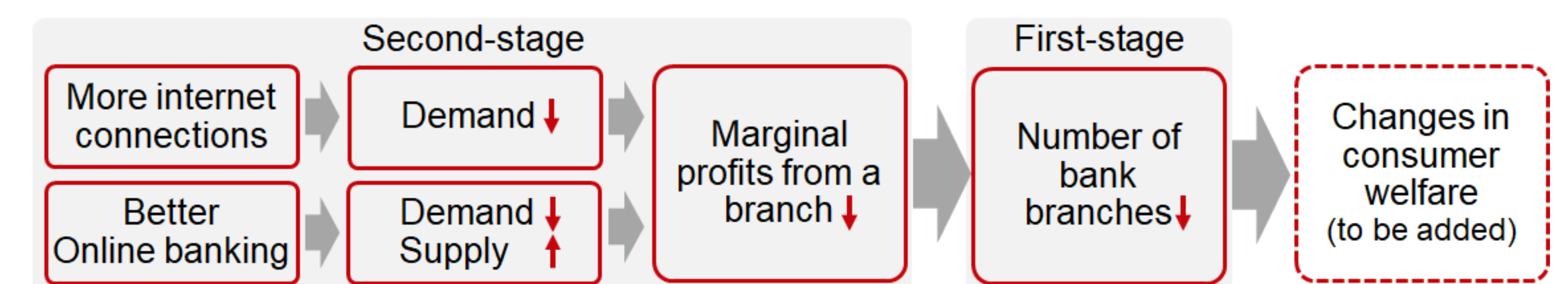
	First stage	Second stage
Model	• Banks open/close branches based on expectations on marginal profits from branches. • Dynamic discrete game in continuous time	• Given the number of branches, consumers choose a bank to make deposits. • Static demand model
Decision	• To open/close a branch	• Deposit rate
Goal	• To estimate the effect of deposits on the number of branches and profits	• To estimate the effect of the internet on deposits and consumer welfare
Estimation	• Nested pseudo likelihood estimator in continuous time	• GMM estimation using a nested logit model

- Increase in the number of internet connections: More consumers will use online banking and there will be more options available for them (second-stage). This will lead to banks' strategic behavior on choosing the number of branches (first-stage).
- Better online banking quality: New customers can be induced to open an account (market expansion effect) but existing customers can switch to online banking (sales diversion effect), hence the number of bank branches will change.



## Estimation results

- **Implication 1 (Demand side)** Negative effects of online banking service quality on market shares (**Market expansion effect < Sales diversion effect** in this model)
- **Implication 2 (Supply side)** More branches increase marginal costs and better online service quality decreases marginal costs.
  - Both increase in online banking service quality and internet connections decrease marginal profits from a branch.
- **Implication 3 (Branch opening/closure game)** Marginal profits from a branch increases the number of bank branches, which implies that online banking service quality and internet connections accelerates bank branch closures.



## Conclusion

- This paper develops a two-stage model with a dynamic discrete game on branch openings/closures in continuous time and a demand model for deposits for five largest U.S. banks.
- The estimation results for the demand model imply that both **internet connections and better online banking quality have negative effects on marginal profits from branches**. Since marginal profits of branches positively affect branch profits in the branch opening/closure game, **the internet causes bank branch closures**.
- Considering the fact that some consumers still need bank branches, regulations on branch closings in rural areas and branch redesign cutting down operation costs may be needed.
- Estimated effects of the internet on consumer welfare are to be added in the future.

## References

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