Does the Internet Replace Brick-and-Mortar Bank Branches?

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Motivation

JPMorgan Chase to close hundreds of bank branches

FEBRUARY 24, 2015 / 2:50 PM / AP

NEW YORK - JPMorgan Chase (JPM) plans to close 300 bank branches over the next two years, about 5 percent of the total, as more customers move online and the bank seeks to cut costs.

The closures are part of a $1.4 billion cost-cutting plan the bank announced for this year. The latest developments were revealed during the bank's annual investor day conference Tuesday.

Online and mobile banking have become increasingly popular and that trend is expected to continue. The shift online has begun to make brick-and-mortar branches less necessary and, frankly, expensive.

Tellers handled only 42 percent of all bank deposits last year, according to JPMorgan, down from 90 percent in 2007. Banks have made even visits to an ATM less necessary, introducing technology that only requires customers to take a picture of a check with a smartphone to make a deposit.

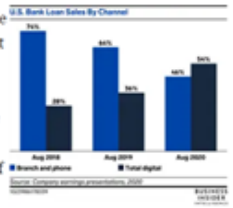
U.S. Bank will close 400 branches by early next year, as it continues to report robust digital engagement

Gregory Magana Oct 19, 2020, 9:20 AM

- U.S. Bank will close 400 branches by early next year.
- The move comes after announcing that the percentage of its customers who are digitally active was above the three-quarters mark, standing at 76% as of August 31, 2020.
- Insider Intelligence publishes hundreds of research reports, charts, and forecasts on the Banking industry with the Banking Briefing. You can learn more about subscribing here.

Last week's announcement coincided with the bank's Q3 2020 earnings report, which revealed its net income plunged 17.2% year over year (YoY) to $1.58 billion.

U.S. Bank also noted that it set aside $635 million in provisions for credit losses, marking a 63% decrease from the $1.74 billion it set aside in Q2 2020 during the height of the coronavirus pandemic. The bank also reported that the percentage of customers who are digitally active was above the three-quarters mark,

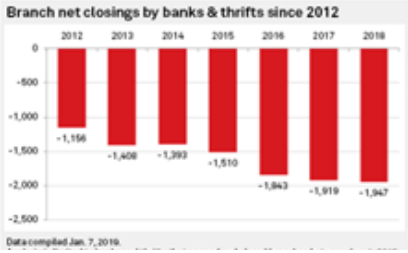


U.S. Bank will close 400 branches.

US bank branch closures reach another high in 2018

U.S. bank branch closures reached a new high in 2018 as consumers continued to migrate to online and mobile banking options.

Retail banking has been defined by widespread closures in recent years, with net branches shuttered totaling 1,947 branches in 2018, up from 1,919 in 2017. The wave of closures appears here to stay: In S&P Global Market Intelligence's most recent mobile banking survey, a better mobile app experience was the No. 4 reason customers gave for considering a bank switch, beating out a broader branch footprint.



"It's obviously not going to go to zero, but I would expect it to continue," said James Barth, a finance professor at Auburn University. "Banks are deciding you don't need as many branches. You need them in strategic locations where you can have the biggest bang for your buck."

Consolidation in the industry has also

Impact of bank branch closures

- Primary method used to access bank accounts (%)

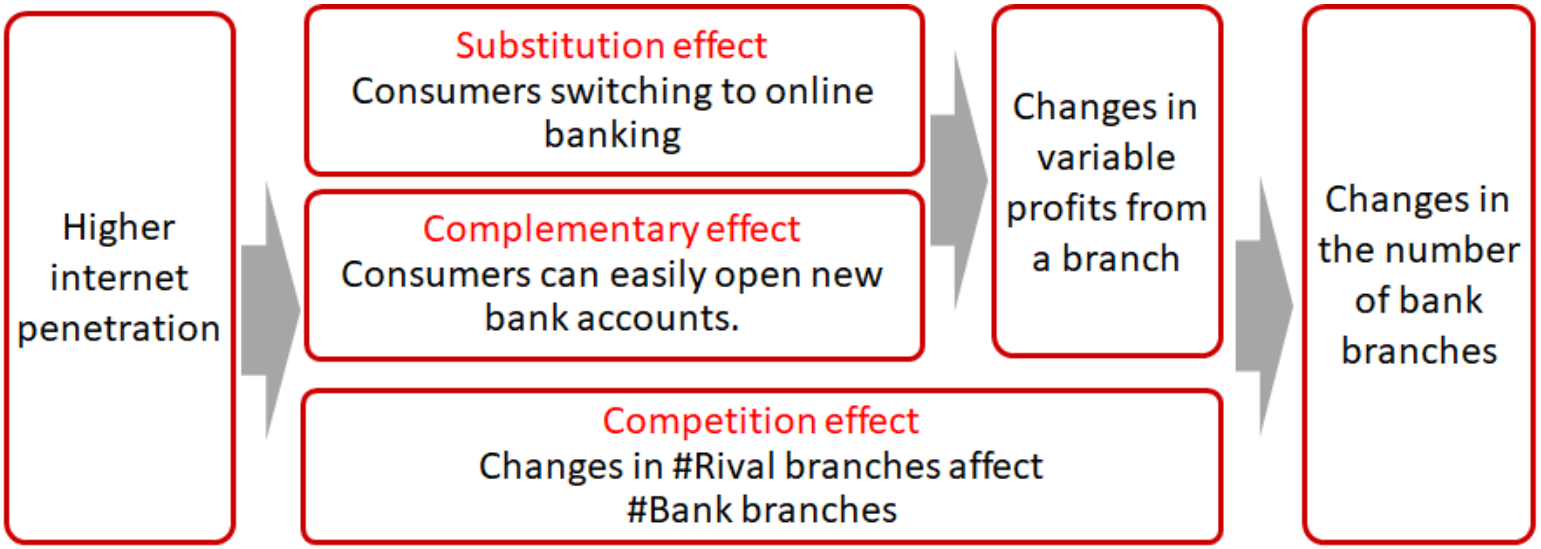
Family income	Bank teller	ATM /Kiosk	Telephone banking	Online banking	Mobile banking	Other
Less than 15K	38.8	26	4.1	17.2	11.2	2.2
15K to 30K	38.0	24.5	4.3	19.4	11.7	1.5
30K to 50K	28.9	22.8	3.4	27.7	16.0	0.8
50k to 75K	23.3	18.7	3.0	38.0	15.8	0.4
At least 75K	13.3	15.5	1.8	50.6	17.9	0.2

Note: For all banked households that accessed their account in the past 12 months
Source: FDIC National Survey of Unbanked and Underbanked Households (2018)

- Bank branch closings have large negative effects on credit supply to local small businesses (Nguyen, 2019).

Research question

- How does the internet affect bank branches and consumer welfare in retail banking industry?



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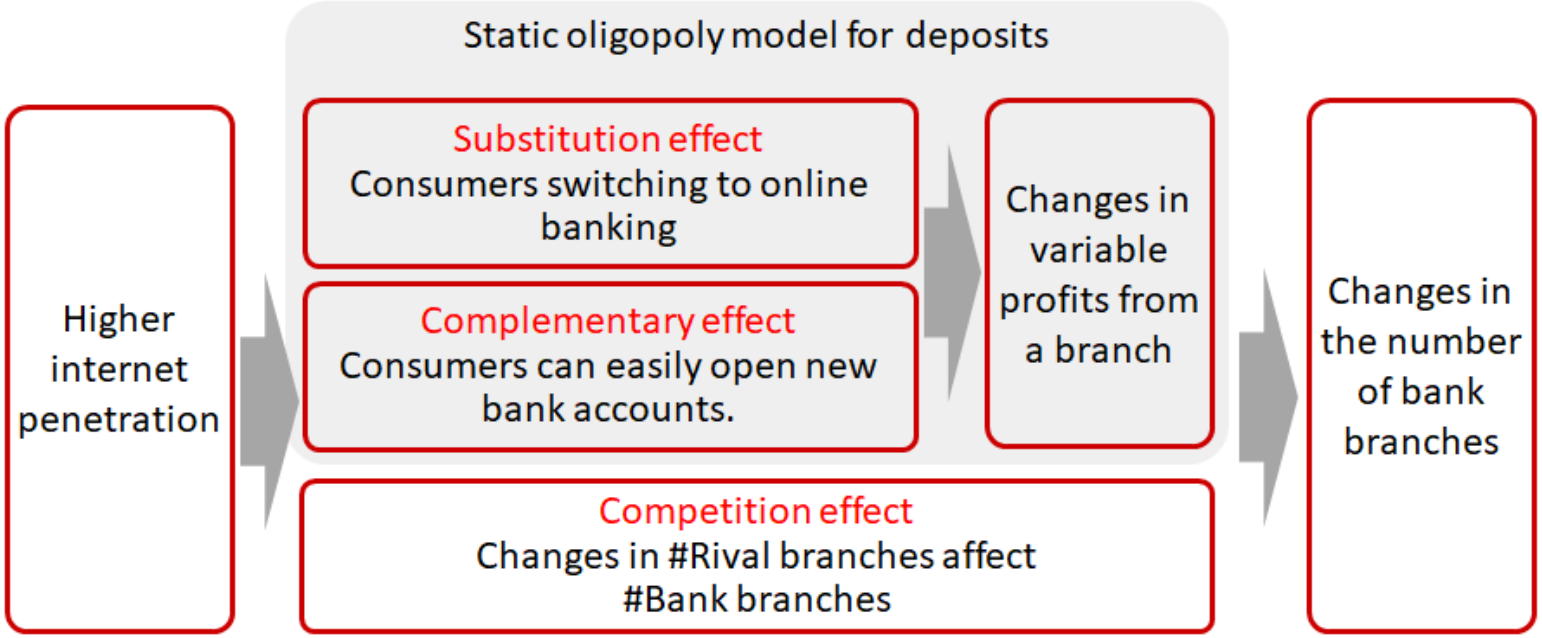

- Static oligopoly model for deposits
  - (Demand side) Consumers choose a bank to make deposits considering their internet availability.
  - (Supply side) Banks set their deposit rate.

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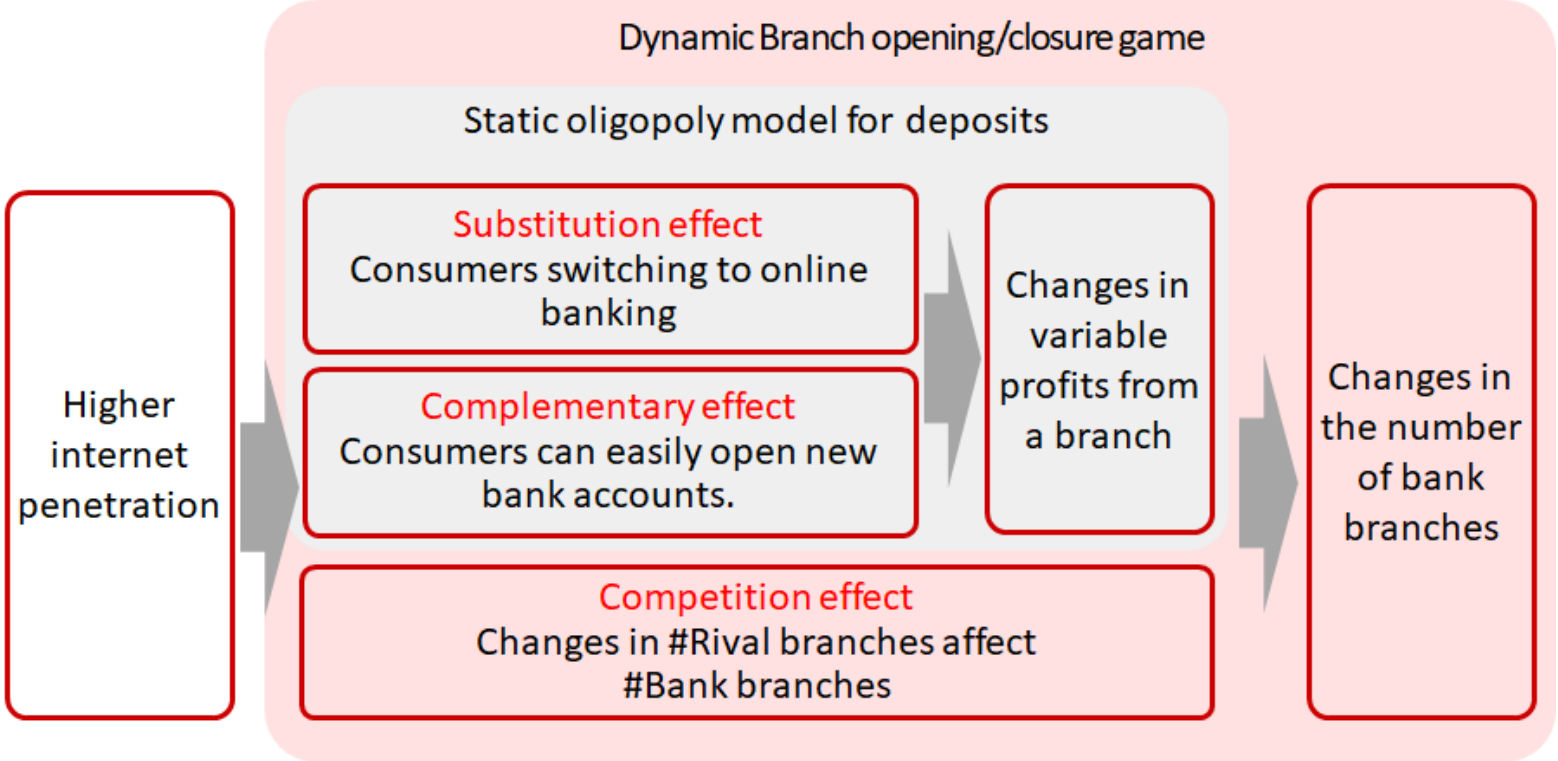

- Dynamic branch opening/closure game
  - Banks open or close branches based on expectations on variable profits (from the static model) and the number of own/rival branches.

Findings

- How does the internet affect bank branches and consumer welfare in retail banking industry?

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- The effect of the internet on bank branches and consumer welfare depends on
  1. Minimum internet penetration rate for all markets
  2. Income

Findings

- How does the internet affect bank branches and consumer welfare in retail banking industry?
- The effect of the internet on bank branches and consumer welfare depends on
  1. Minimum internet penetration rate for all markets
  2. Income

	Internet ≥ 60%		Internet ≥ 80%	
	#Branches	CS	#Branches	CS
All markets	#Branches decreases by 11%.	Consumers lose $118 on average.	#Branches stays same as the current #Branches.	Consumers gain $605 on average.
Low-income markets	#Branches decreases by 19%.	Consumers lose $146 on average.	#Branches decreases by 0.5%.	Consumers gain $794 on average.
High-income markets	#Branches decreases by 6%.	Consumers lose $99 on average.	#Branches increases by 1%.	Consumers gain $38 on average.

Literature

	Topic	Literature
Research question	Effects of online channel on offline channel in retail industry	- Goolsbee (2001): PC - Deleersnyder et al. (2002), Gentzkow (2007): Newspaper - Pozzi (2013): Supermarkets - Duch-Brown et al. (2017): Consumer electronics
	Branch opening/closure	- Cohen & Mazzeo (2007): Endogenous market structure model in rural markets by bank types - Aguirregabiria, Clark, Wang (2016; 2017), Kuehn (2018): Structural models of bank competition with interconnected markets
	Demand model for deposits	- Dick (2008): Demand for bank deposits after deregulation - Ishii (2005), Kuehn (2018): Two stage model with demand for deposits and ATM/branch network choice
Estimation method	NPL estimator	- Aguirregabiria & Mira (2002, 2007) - Kasahara & Shimotsu (2012), Bugni & Bunting (2018)
	Dynamic discrete choice model in continuous time	- Doraszelski & Judd (2012): Theoretical model - Arcidiacono, Bayer, Blevins, Ellickson (2016): Empirical model - Blevins (2018): Econometric properties - Blevins & Kim (2021): Continuous time NPL estimator

Outline

Outline

Data summary

- Market definition: County (Aguirregabiria et al., 2016; Clark et al., 2017)
- Static oligopoly model for deposits
  - Consumers choose a bank to make deposits considering their internet availability.
  - Banks set their deposit rate.

Variable	Data
Market share	Deposit by bank/market
Price	Deposit rate
Product characteristics	- #Branch - Online banking quality
Market characteristics	- Internet penetration - Income

Data summary

- Dynamic branch opening/closure game
  - Banks form expectations on variable profits and decide whether to open a branch and pay fixed costs.

Variables	Data
Variable profits	(Estimated from the static model)
Branch opening/closures	- #Branch - Branch opening/closure dates

Data summary

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Variables	Data
Variable profits	(Estimated from the static model)
Branch opening/closures	- #Branch - Branch opening/closure dates

- Data source

Data	Data set	Source
Bank characteristics	#Branches, Deposits Deposit rates Opening/closure dates	FDIC
Internet	Internet penetration Online banking	FCC Spyfu, Google
Market characteristics	Income	Census Bureau

Summary of Deposits

- Annual survey of branch office deposits as of June 30 for all FDIC-insured institutions (Federal Deposit Insurance Corporation, FDIC)
  - Time period: 1994∼2019 (2010∼2018 used)
  - Variables: locations, total deposits, opening/closure dates, etc.
- Focused on five banks that have the largest number of branches in 2010–2018 in the branch opening/closure game.

Bank	Branches	Market share
Wells Fargo	6,204	9.9
J.P. Morgan Chase	5,450	9.8
Bank of America	5,192	10.9
US Bank	3,161	2.5
PNC Bank	2,726	2.2

Internet penetration

- Form 477 County Data on Internet Access Services (Federal Communications Commission, FCC)
- Residential Fixed Internet Connections over 200 kbps in at least one direction per 1,000 households

Internet penetration (%)	Index	2010 (%)	2018 (%)
0	0	0.1	0
$0 \sim 20$	1	2.4	0.3
$20 \sim 40$	2	20.6	2.2
$40 \sim 60$	3	44.1	20.7
$60 \sim 80$	4	27.9	52.1
$80 \sim 100$	5	4.8	24.7

Note: Percentage of counties in 2010 and 2018

Summary statistics

- Bank-county-year observations (static model)
- Counties with population less than 250,000 (rural + nonmetro + small metro counties)
- Proxies for online banking quality
  - Bank: Log of website search traffic
  - Credit union: Fraction of members with online account

Variable	Mean	(s.d.)
Deposit rate	0.2559	(0.1977)
Loan rate	2.4915	(0.6491)
Branch	2.3166	(2.0398)
Internet	3.9131	(0.7149)
Bank online banking quality	10.1664	(5.9990)
Credit union online banking quality	0.3459	(0.1566)
Data period	2010–2018	
Nobs.	118,027	

Outline

Model framework

- Banks decide to open/close a branch by playing an infinite horizon game.
- Every year, consumers decide which bank to make deposits and banks set the deposit rate.

	Static oligopoly model for deposits	Dynamic branch opening/closure game
Model	• Consumers choose a bank to make deposits. • Banks choose deposit rate.	• Banks open/close branches based on expectations on variable profits from branches in continuous time.
Goal	• To estimate the effect of the internet on variable profits and consumer welfare • To estimate the substitution and complementary effect	• To estimate the effect of variable profits on bank branches. • To estimate the competition effect • To estimate fixed costs for opening branches
Estimation	• IV-OLS using a nested logit model	• Continuous time NPL
Banks included	• All banks/credit unions	• Five largest banks

Outline

Setting

- Demand side: Nested logit model
  - Consumer i chooses bank $b = 1, 2, \ldots, B_{mt}$ or in credit unions.
    - Group 1: 5 largest U.S. banks
    - Group 2: Other national banks
    - Group 3: Community banks
    - Group 4: Credit unions
    - Group 0 (outside option): "Unbanked" (no bank or credit union accounts)
  - Assumption: More likely to switch banks within a group
- Supply side
  - Bank b chooses deposit rate to maximize aggregate variable profits across markets.

Demand side: Utility function

$$u_{ibmt} = \underbrace{\alpha \text{DepR}_{bt} \times \text{Income}_{mt}}_{\text{Deposit interest}} + \underbrace{\beta_1 \log(\text{Branch}_{bmt})}_{\#\text{Branches}} + \underbrace{\beta_2 \text{Internet}_{mt} \times \log(\text{Branch}_{bmt})}_{\text{Substitution btwn internet \& branches}}$$

$$+ \underbrace{\beta_3 \text{Online}_{bt} \times \mathbb{1}(\text{Bank}_b) + \beta_4 \text{Website}_{bt} \times \mathbb{1}(\text{CreditUnion}_b)}_{\text{Online banking quality}}$$

$$+ \underbrace{\beta_5 \text{Internet}_{mt}}_{\text{Internet index}} + \underbrace{\beta_6 \log(\text{Income}_{mt})}_{\text{Median income}} + \underbrace{\xi_{bm} + \xi_t}_{\text{Fixed effects}} + \xi_{bmt} + \varsigma_{igmt} + (1-\sigma)\varepsilon_{ibmt}$$

Can be measured	Cannot be measured
Deposit interest	Fixed effects
#Branch	Unobservable bank characteristics
Online banking quality	Group preference
Internet	Variation in consumer tastes
Income	

Demand estimation

- Market share inversion based on Berry (1994)
- Instrument: Average deposit rate/number of branches of other banks in the market (and their quadratics)

$$\log\left(\frac{s_{bmt}}{s_{0mt}}\right) = \underbrace{\alpha \text{DepR}_{bt} \times \text{Income}_{mt}}_{\text{Deposit interest}} + \underbrace{\beta_1 \log(\text{Branch}_{bmt})}_{\#\text{Branches}} + \underbrace{\beta_2 \text{Internet}_{mt} \times \log(\text{Branch}_{bmt})}_{\text{Substitution btwn internet \& branches}}$$

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Demand estimation results

$$\log\left(\frac{s_{bmt}}{s_{0mt}}\right) = \underbrace{\alpha \text{DepR}_{bt} \times \text{Income}_{mt}}_{\text{Deposit interest}} + \underbrace{\beta_1 \log(\text{Branch}_{bmt})}_{\#\text{Branches}} + \underbrace{\beta_2 \text{Internet}_{mt} \times \log(\text{Branch}_{bmt})}_{\text{Substitution btwn internet \& branches}}$$

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Variables	Estimates	(S.E.)
DepR × Income	1.0603	(0.0522)
log(Branch)	1.0836	(0.0462)
Internet × Branch	-0.0718	(0.0084)
Online × $\mathbb{1}$(Bank)	0.0017	(0.0015)
Website × $\mathbb{1}$(CreditUnion)	0.9015	(0.1011)
Internet	0.1027	(0.0104)
log(Income)	0.3323	(0.0688)
Constant	-6.7300	(0.7460)
$\log(s_{b\|g})$	0.0834	(0.0177)
R^2	0.6005	
First stage F-stat	972.77	

First stage

Supply side: Effects of the internet on variable profits

- Banks maximize the aggregate variable profits from deposits.

$$\Pi_{bmt} = (\text{LoanR}_{bt} - \text{DepR}_{bt} - mc_{bmt})\text{Deposit}_{mt} * \hat{s}_{bmt}$$

- Profit maximization

$$\underbrace{\frac{\sum_m \text{Deposit}_{mt} s_{bmt}}{\sum_m \text{Deposit}_{mt} \frac{\partial s_{bmt}}{\partial \text{DepR}_{bt}}}}_{MR} = \underbrace{mc_{bt}}_{MC}$$

Average % change in variable profits	Internet≥40%	Internet≥60%	Internet≥80%
All markets	0.008	0.067	-0.434
By income			
Less than 40K	0.078	0.525	0.977
40K∼50K	0.011	0.078	0.273
50K∼75K	-0.002	-0.002	-0.969
More than 75K	0.000	0.009	-0.209

Implication 1 (Static oligopoly model for deposits)

- Effects of higher internet penetration on variable profits
  - Substitution effect: Consumers switching to online banking (variable profits ↓)
  - Complementary effect: Consumers make more deposits (variable profits ↑)

Average % change in variable profits	Internet≥40%	Internet≥60%	Internet≥80%
All markets	0.008	0.067	-0.434
By income			
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Substitution < Complementary

Substitution > Complementary

Implication 1 (Static oligopoly model for deposits)

- Low-income markets: Less branches to substitute from and higher unbanked rate
- High-income markets: More branches to substitute from and lower unbanked rate

Average % change in variable profits	Internet≥40%	Internet≥60%	Internet≥80%
All markets	0.008	0.067	-0.434
By income			
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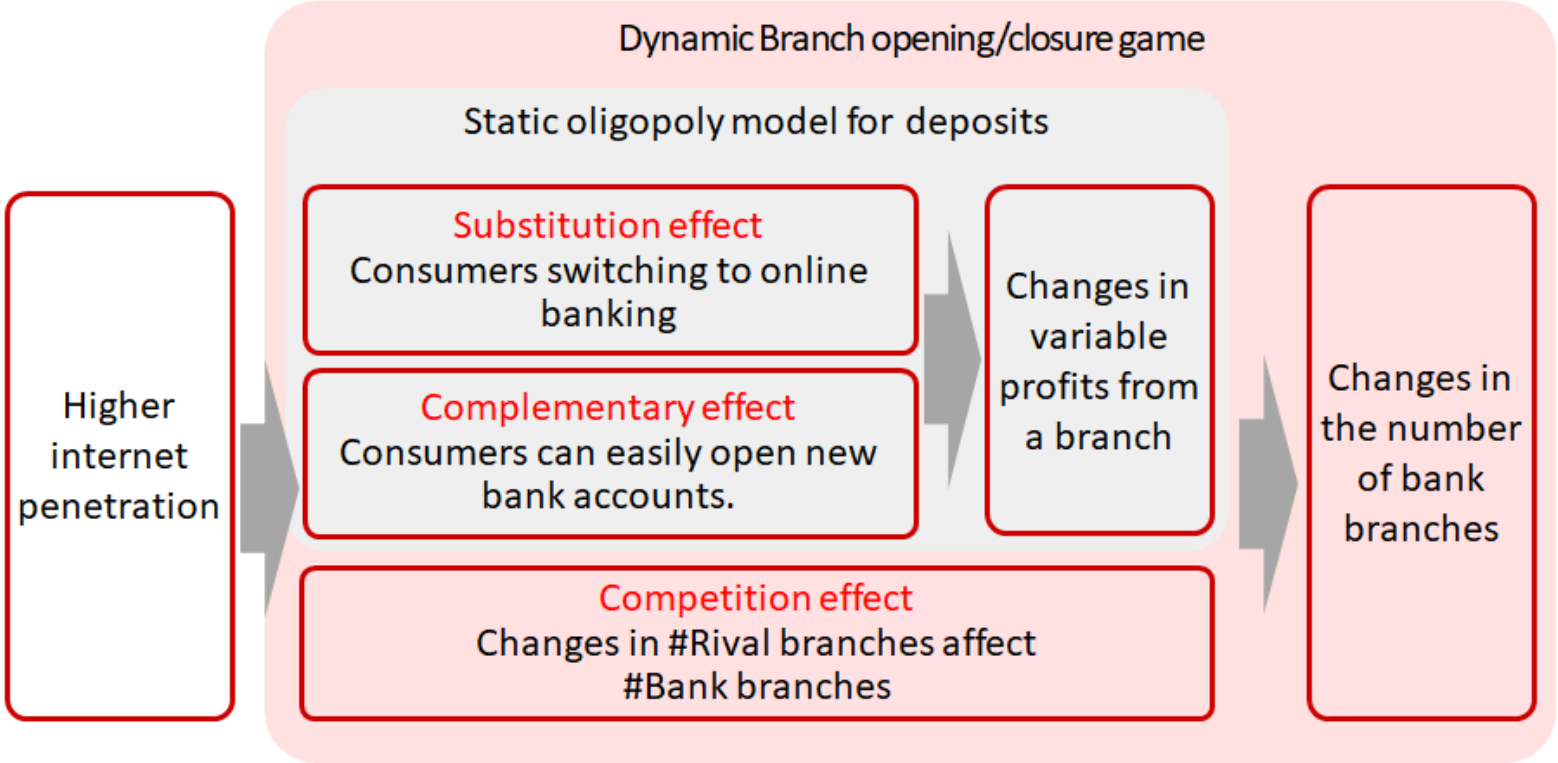
Substitution > Complementary

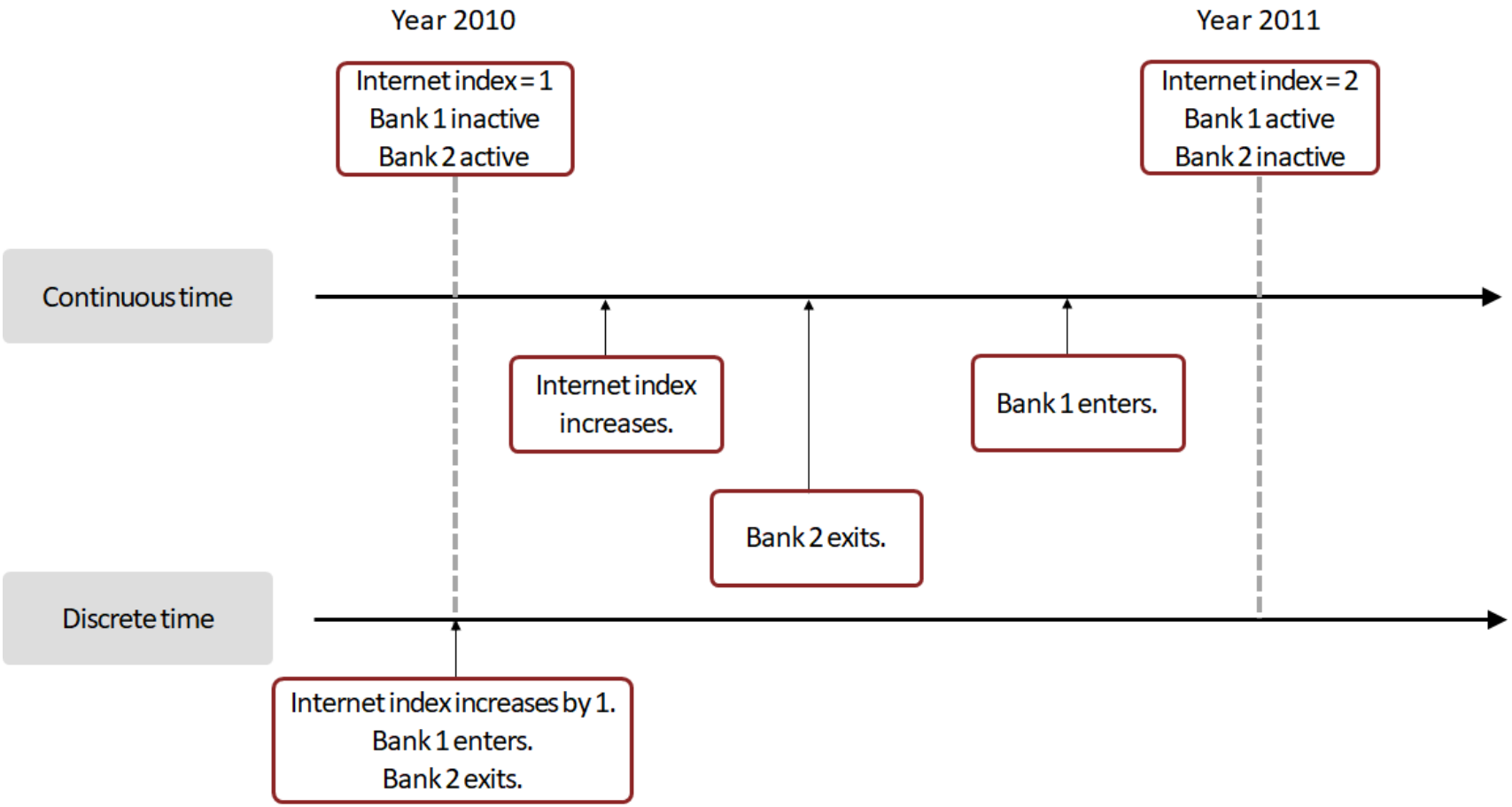
Linking the static model for deposits to the dynamic branch opening/closure game

- What I have: Variable profits as a function of bank and market characteristics including the internet penetration rate
- How does the change in the internet affect variable profits from branches?



Outline

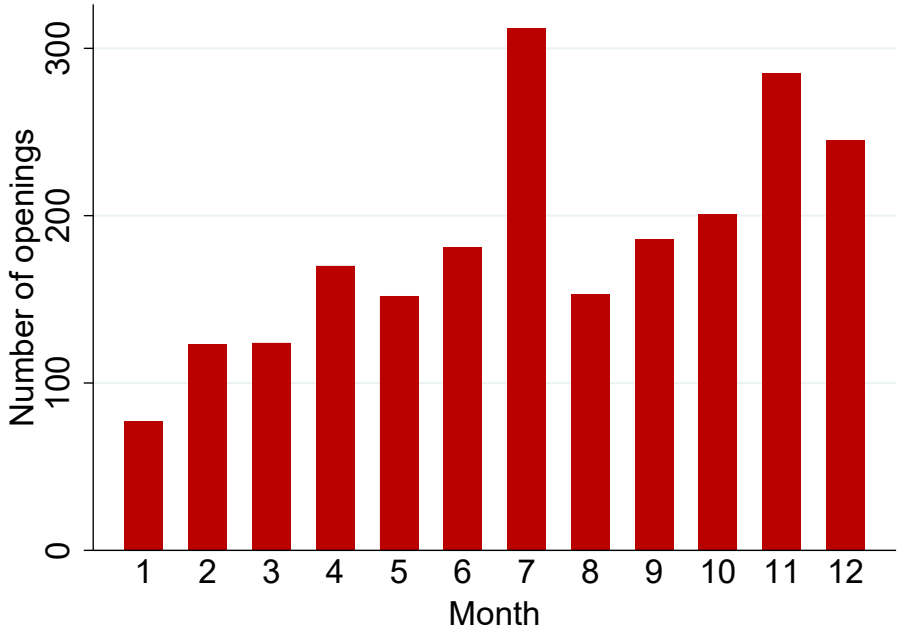
Continuous time vs discrete time



- If the data was generated in continuous time but a discrete time model is estimated, the bias is large, especially for parameters on strategic interactions (Blevins and Kim, 2021).

Why continuous time?

- Closer approximation to reality



- Computational benefits
  1. Discrete time: Simultaneous move of variables–5 banks can move to 10 states $\rightarrow 5^{10}$ possible states
  2. Continuous time: Only allows one bank to move at an instant (open, close, do nothing) $\rightarrow 5 \times 3$ possible states

Setting

- An infinite horizon game with 5 banks ($b = 1, 2, \ldots, 5$)
- Bank b receives an opportunity to open or close a branch according to Poisson process.
- Banks choose their action j in continuous time $t \in [0, \infty)$.

$$\begin{cases} j = 1 & \text{open a new branch} \\ j = -1 & \text{close an existing branch} \\ j = 0 & \text{do nothing} \end{cases}$$

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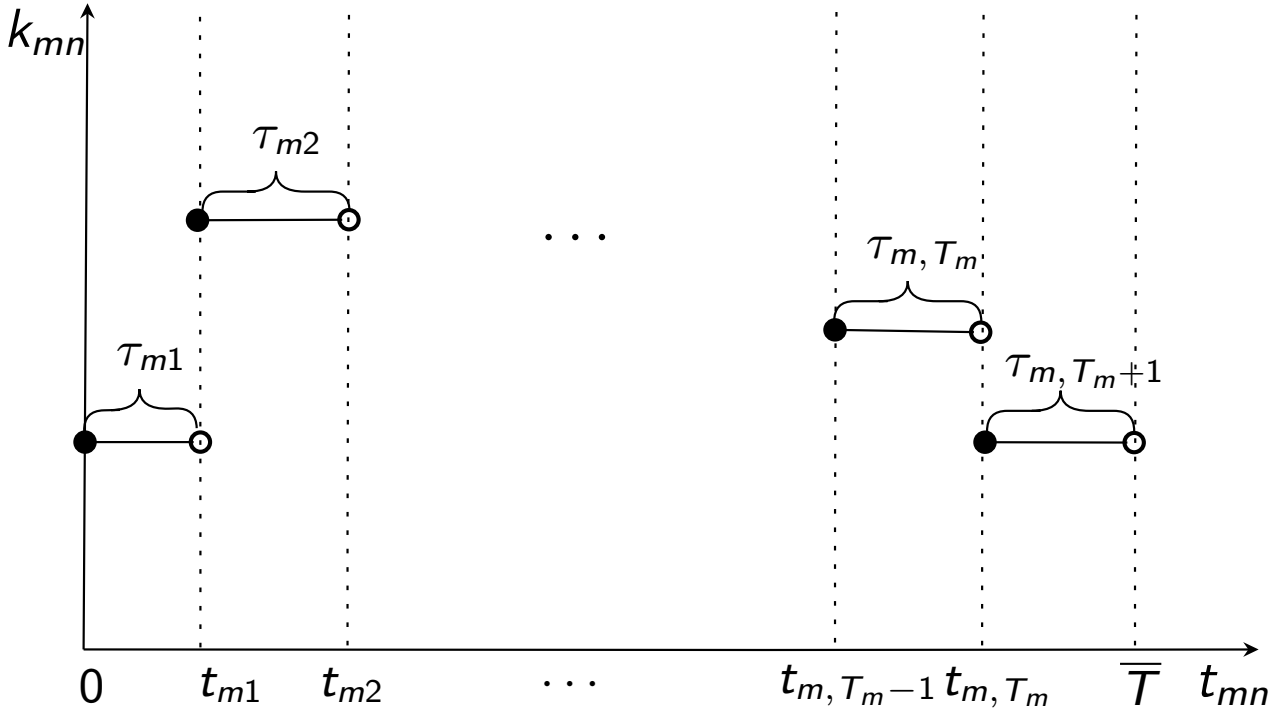
- State space $\mathcal{X}$ is finite and discrete, each state represented by a state number k.
  1. Branch_{bk}: number of bank b's branches
  2. $\text{Rival}_{bk} = \sum_{b' \neq b} \text{Branch}_{bk}$: number of other banks' branches
  3. MP_k: Average marginal variable profits from the first branch open in the market (same for all banks)

$$x_{bk} = (\text{Branch}_{bk}, \text{Rival}_{bk}, \text{MP}_k).$$

- Conditional choice probability: σ_{bjk}

Continuous time data structure

- Dataset: $\{k_{mn} : m = 1, \ldots, M, n = 0, \ldots, T_m\}$ where k_{mn} is the state index at the instant n when an event occurs



- Transition rate: Counterpart to transition probability in discrete time models
  - Endogenous change: $q_{bk} = \lambda\sigma_{bjk}$ (move arrival rate $\times$ bank b's conditional choice probability of choosing action j at state k)
  - Exogenous change: q_{0k}

Payoffs

1. Flow payoff: Banks receive flow payoff for being active at state k.

$$u_{b,k_{mn}} = \theta_{0,b} + \theta_1 VP_{b,k_{mn}}(\#\text{Branch}_{b,k_{mn}}, \text{Rival}_{b,k_{mn}}, \text{MP}_{k_{mn}}) + \text{RegionFE}_m$$

2. Instantaneous payoff: Banks receive instantaneous payoff when choosing some action j at state k.
   2.1 Deterministic component:
   $$\psi_{bjk} = \begin{cases} -\theta_2 & \text{if bank } b \text{ opens a branch} \\ 0 & \text{otherwise} \end{cases}$$
   2.2 Stochastic component: $\varepsilon_{bjk} \sim$ i.i.d. T1EV

Census region

Value function

- Banks establish the value function based on the expectations on other banks' and nature's moves and own move opportunities.
- What banks know
  - Payoff structure
  - Probability of receiving an opportunity to open/close a branch
  - Probability of rivals opening/closing a branch
  - Probability of changes in exogenous variables
  - Knows when a variable changes
- What banks don't know
  - Whether/when they will receive an opportunity to open/close a branch
  - Whether/when rivals will open/close a branch

Value function

- Bellman equation for a small amount of time h
- Line 1: Current payoff + state change by nature
- Line 2: Expected value from bank b's own moves
- Line 3: Special situations (didn't receive any move opportunity, etc)

$$V_{bk}(\theta,\sigma_b) = \underbrace{\frac{1}{1+\rho_b h}}_{\text{Discount factor}} \Bigg[\underbrace{u_{bk} h}_{\text{Flow payoff}} + \underbrace{\sum_{l\neq k} q_{0kl} h}_{\text{State change by nature}}$$

$$\underbrace{+\,\lambda_{bk}\mathbb{E}\max_j\{\psi_{bjk}+\varepsilon_{bmjk}+V_{l(b,j,k)}(\theta,\sigma_b)\}}_{\text{Bank } b \text{ chooses action } j}$$

$$+\Bigg(\underbrace{1-\lambda_{bk}h}_{\text{No move opportunity}} - \underbrace{\sum_{l\neq k} q_{0kl} h}_{\text{Nature does not move}}\Bigg) V_{bk}(\theta,\sigma_b) + \underbrace{o(h)}_{\text{Multiple move opportunities}} \Bigg].$$

Details

Equilibrium condition

1. Bellman optimality (ABBE, 2016)

$$V(\theta,\sigma) = \Big[(\rho+\lambda)I - \lambda\Sigma(\sigma) - Q_0\Big]^{-1}[u(\theta) + \lambda E(\theta,\sigma)]$$

   - θ: Parameters
   - σ: Conditional choice proability

2. Conditional choice probability

$$\Gamma(v) \equiv \sigma$$

where σ is a $N(J-1) * |\mathcal{X}| \times 1$ vector with

$$\sigma_{bjk} = \Pr[\delta_b(k, \varepsilon_b; \theta, \sigma_b) = j|k].$$

- Policy iteration operator Ψ

$$\sigma = \Psi(\theta,\sigma) \equiv \Gamma(V(\theta,\sigma))$$

Pseudo likelihood function

- Dataset: $\{k_{mn} : m = 1, \ldots, M, n = 0, \ldots, T_m\}$ where k_{mn} is the state index at the instant t when an event occurs
- Pseudo likelihood function

$$L_M(\theta, \sigma) = \frac{1}{M} \sum_{m=1}^{M} \left[\sum_{n=1}^{T_m} \left\{ \underbrace{\ln g(\tau, k; \sigma)}_{\text{State changes}} + \underbrace{\sum_{l \neq k_{mn}} I_{mn}(0, l) \ln q_{k_{mn}, l}}_{\text{Nature changes}} \right.\right.$$

$$\left.\left. + \underbrace{\lambda \sum_{i} \sum_{j \neq 0} I_{mn}(b, j) \ln \sigma_{bjk}}_{\text{Banks make a move}} \right\} + \underbrace{\ln g(\tau_{m, T_m+1}, k_{m, T_m+1}; \sigma)}_{\text{Last state does not change}} \right].$$

where $I_{mn}(k, l)$ is the indicator function which is 1 when agent i chooses action j in market m at time n and 0 otherwise, and

$$g(\tau, k; h) = \exp\left(-\tau \left(\sum_{l \neq k} q_{kl} + \lambda \sum_{j \neq 0} \sigma_{bjk} \right) \right).$$

Continuous time NPL algorithm (Blevins and Kim, 2021)

- Continuous time Nested Pseudo Likelihood (NPL) estimator
- Let $\hat{\sigma}^0$ be an initial guess of the vector of players' choice probabilities. Given $\hat{\sigma}^0$, for $l \geq 1$,

1. Given $\hat{\sigma}^{l-1}$, update $\hat{\theta}$ by

$$\hat{\theta}^l = \underset{\theta \in \Theta}{\operatorname{argmax}}\, L_M(\theta, \hat{\sigma}^{l-1})$$

2. Update $\hat{\sigma}$ using the equilibrium condition, i.e.

$$\hat{\sigma}^l = \Psi(\hat{\theta}^l, \hat{\sigma}^{l-1}).$$

Iterate in l until convergence in σ and θ is reached.

Dynamic branch opening/closure game estimation results

- Starting from logit estimates for conditional choice probabilities, we iterate 20 times to converge to estimates.

$$\begin{cases} u_{b,k_{mn}} & = \theta_{b,0} + \theta_1 VP_{b,k_{mn}} + \text{RegionFE}_m \\ \psi_{bjk} & = -\theta_2 \quad \text{if } j = 1 \end{cases}$$

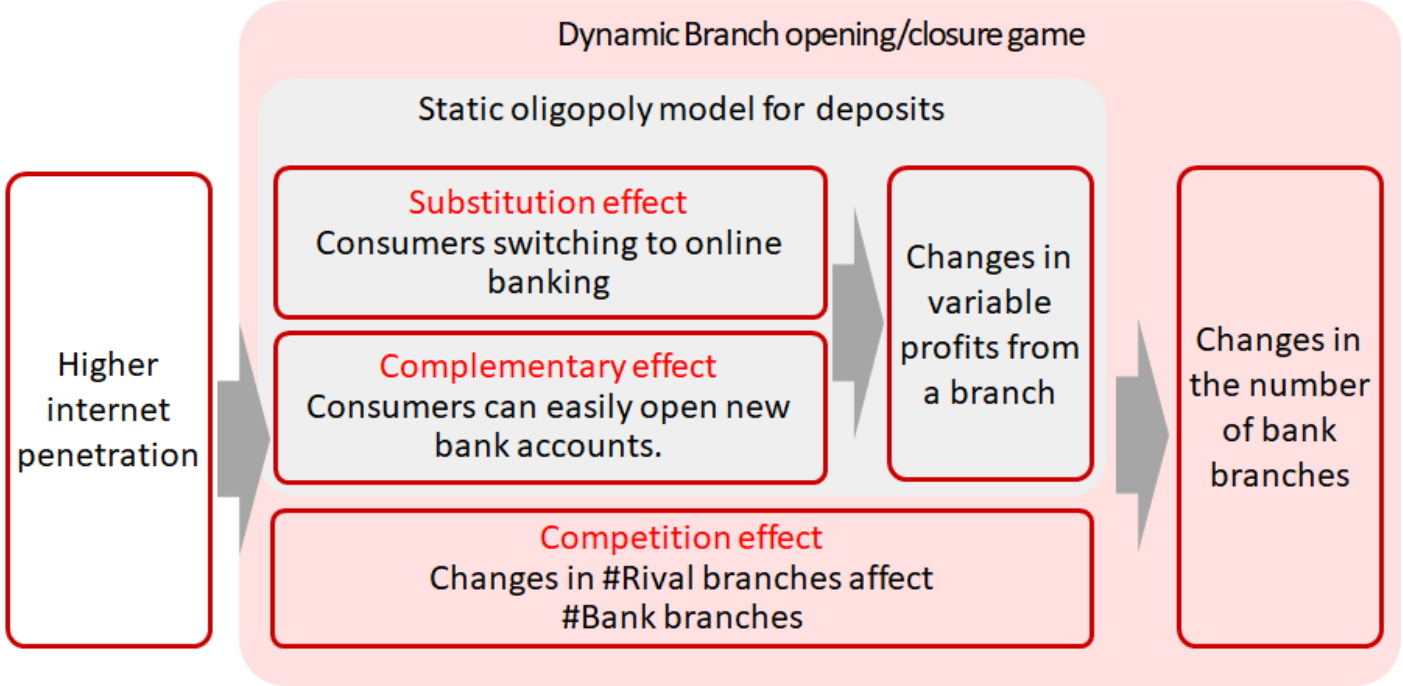
Variables	Estimates	(s.e.)
$\theta_{0,1}$	0.6568	(0.0235)
$\theta_{0,2}$	0.6249	(0.0227)
$\theta_{0,3}$	0.2754	(0.0282)
$\theta_{0,4}$	0.6917	(0.0211)
$\theta_{0,5}$	0.7249	(0.0205)
θ_1	1.2451	(0.0681)
RegionFE_1	-0.1527	(0.0489)
RegionFE_2	-0.0733	(0.0183)
RegionFE_3	0.0333	(0.0170)
θ_2	6.4427	(0.0809)

Implication 2 (Dynamic branch opening/closure game)

- Variable profits from branches increases branch openings:

$$u_{bk} = \theta_{0,b} + 1.2451 VP_{bk} + RegionFE$$

- Internet connections increase (decrease) variable profits which in turn increases (decreases) the number of branches.



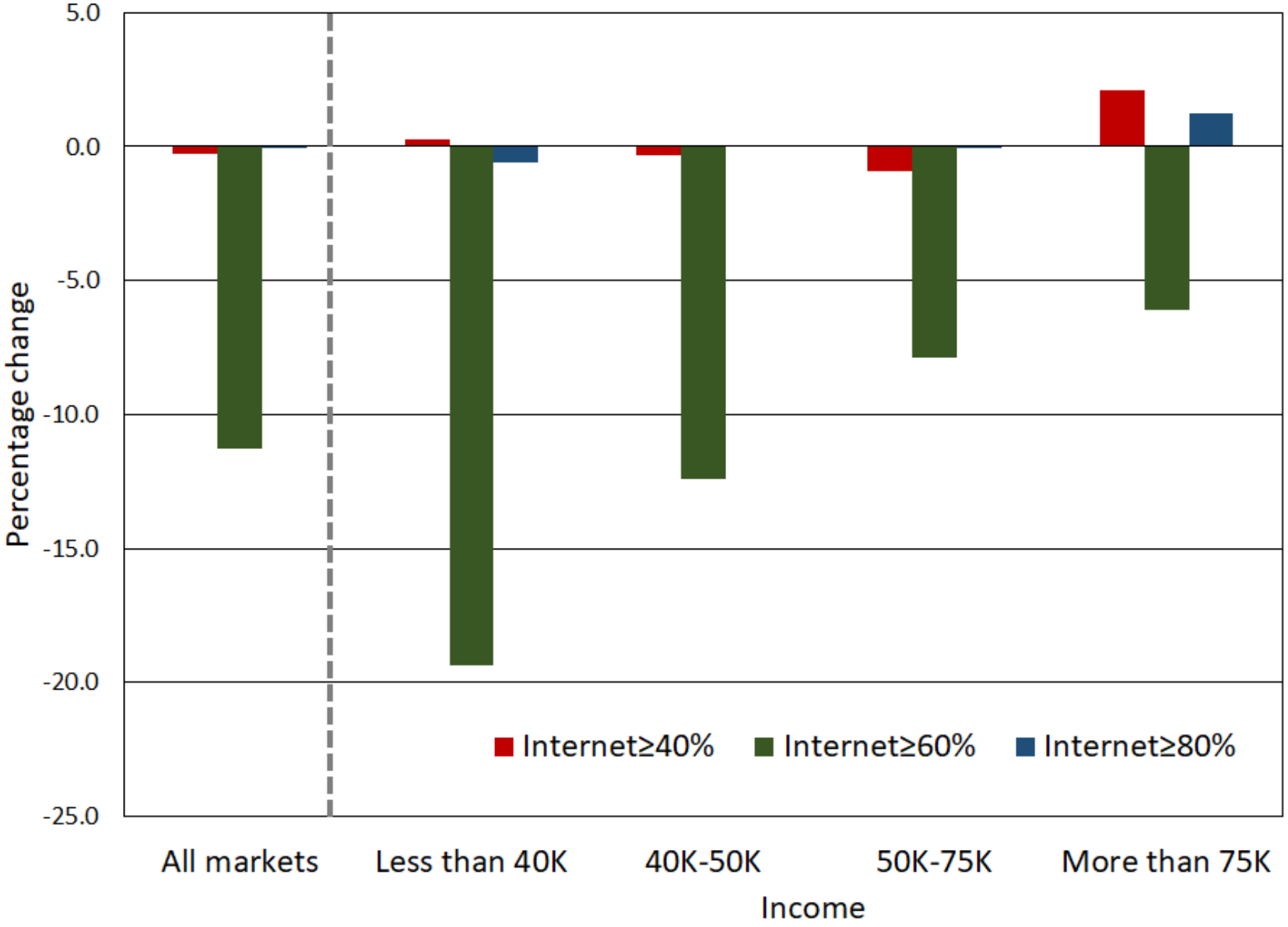
Counterfactuals: Higher internet penetration

- How does the number of bank branches and consumer welfare change when at least 40%, 60%, and 80% of households have an access to the internet?
- Increase the internet penetration rate in the utility function and look at the changes in
  1. Number of branches
  2. Consumer welfare

Internet penetration (%)	Index
0	0
$0 \sim 20$	1
$20 \sim 40$	2
$40 \sim 60$	3
$60 \sim 80$	4
$80 \sim 100$	5

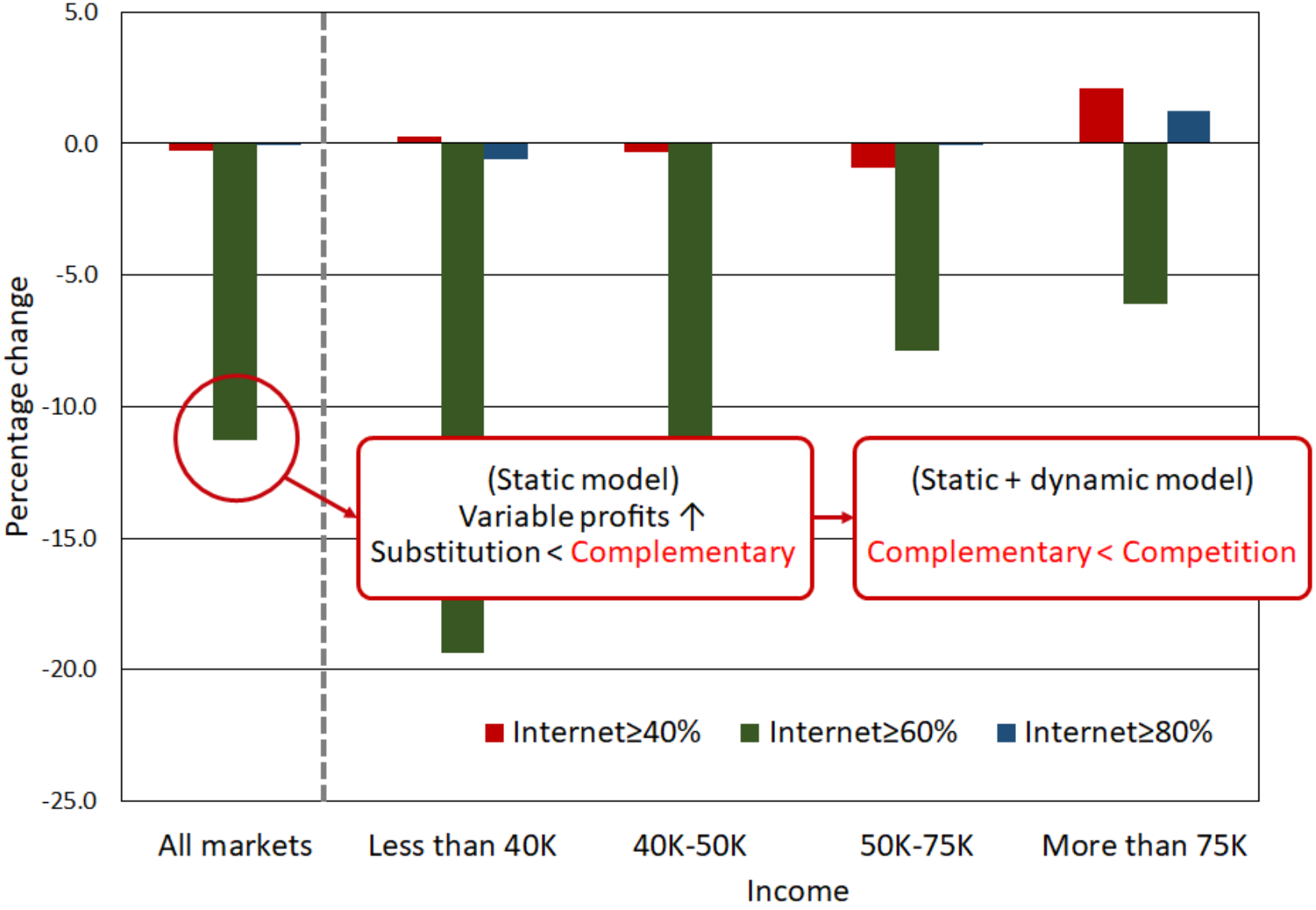
Effects of higher internet penetration on bank branches

- Benchmark: #Branches with current internet penetration rate in 2018



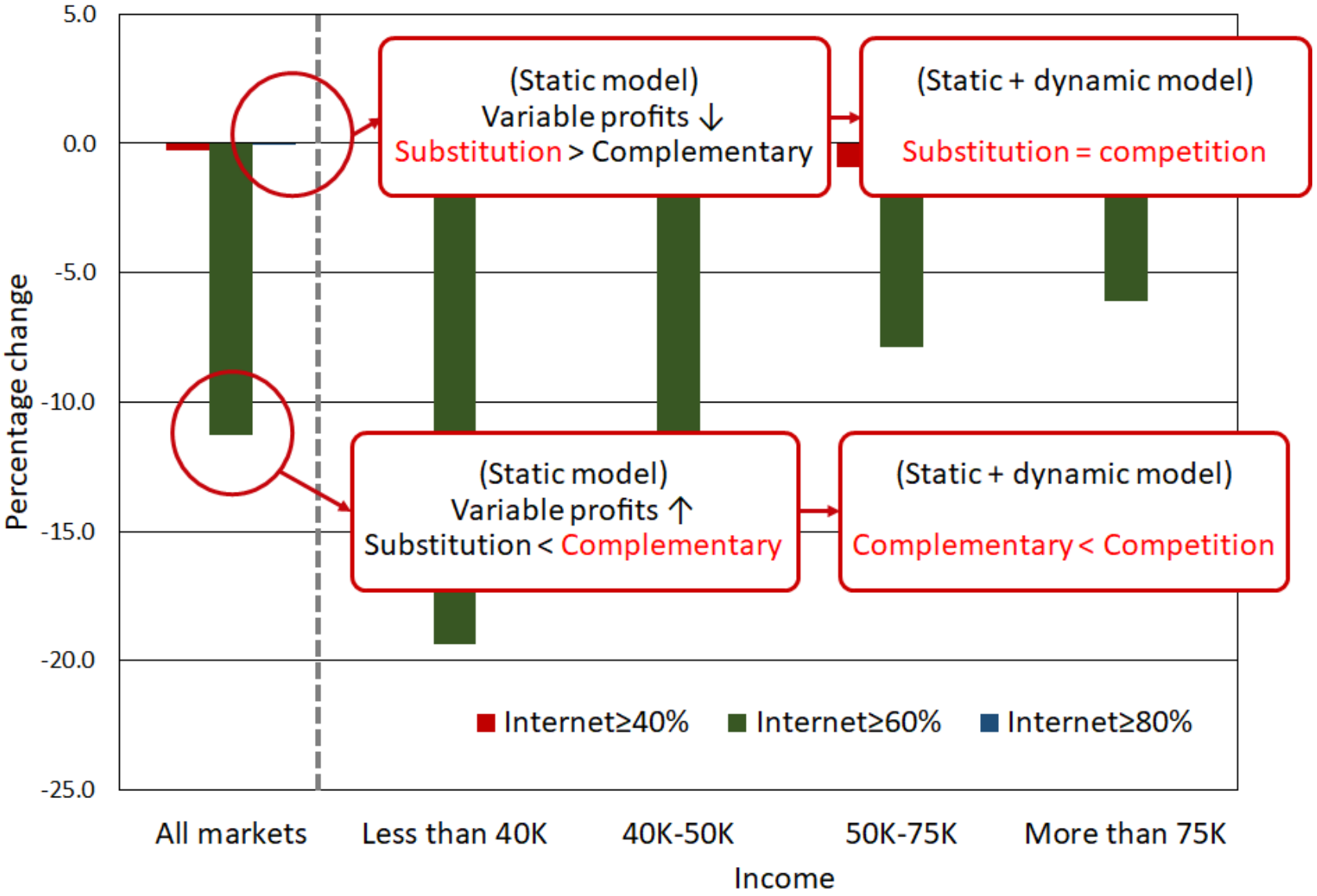
Effects of higher internet penetration on bank branches

- Benchmark: #Branches with current internet penetration rate in 2018



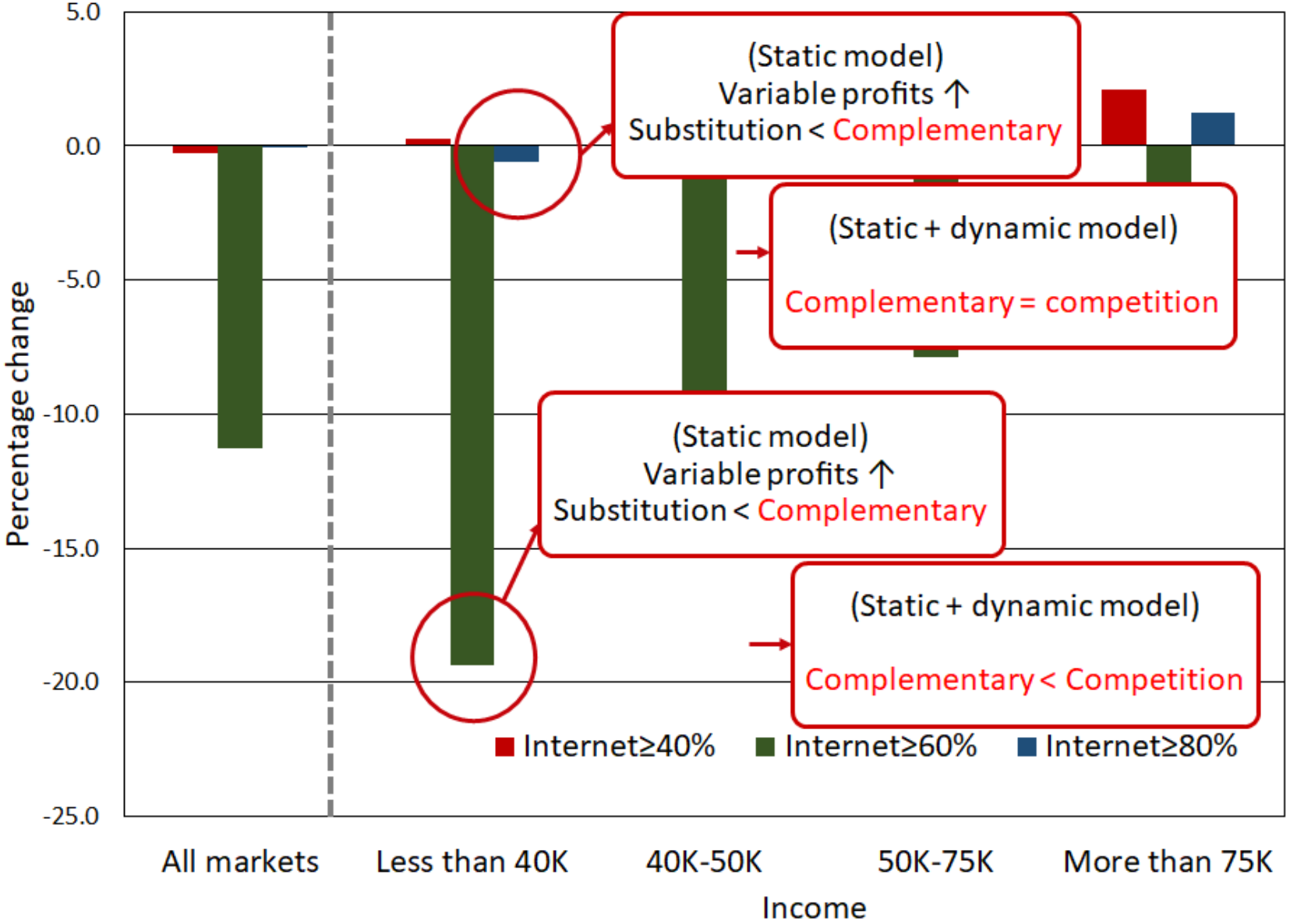
Effects of higher internet penetration on bank branches

- Benchmark: #Branches with current internet penetration rate in 2018



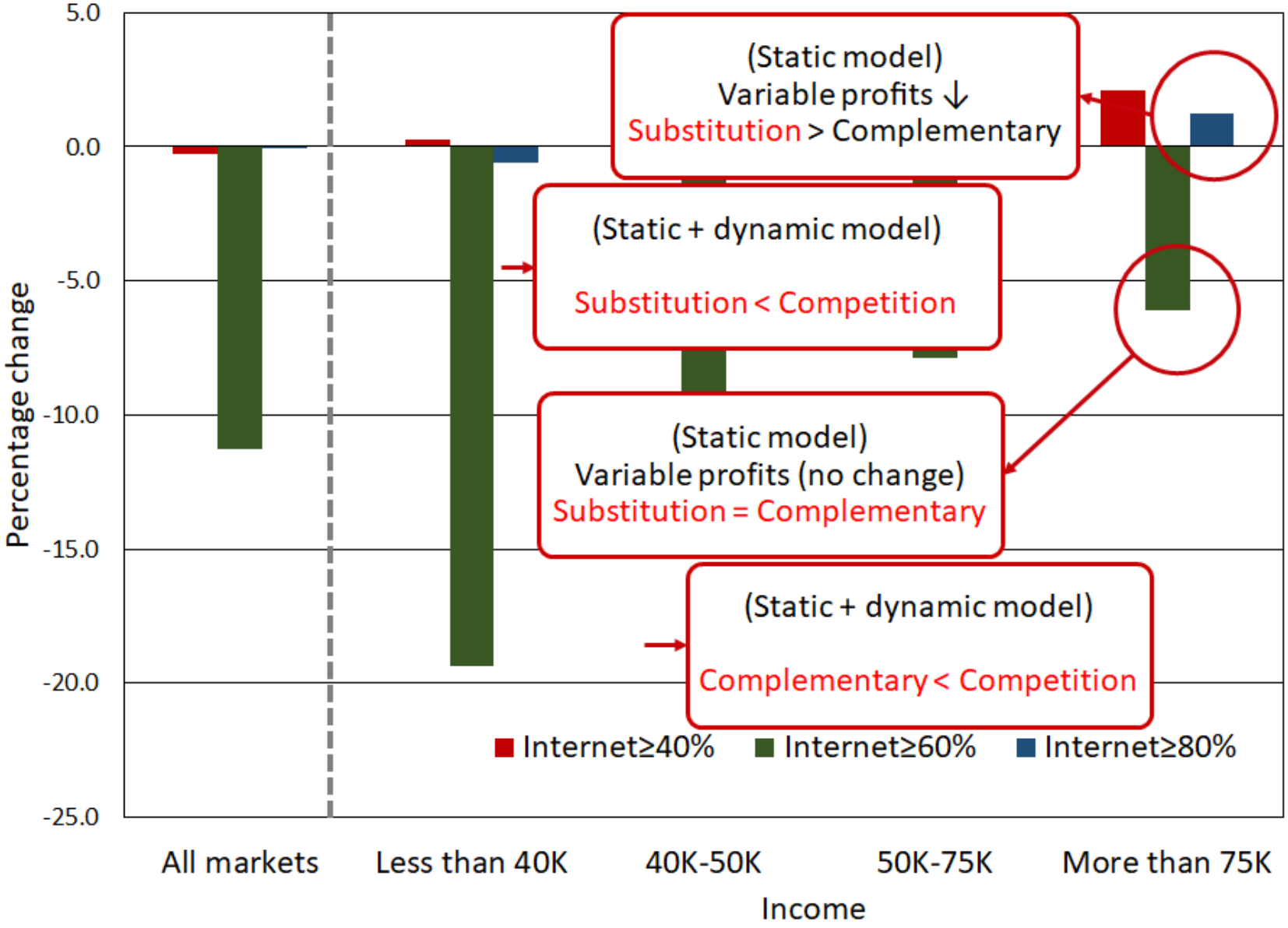
Effects on bank branches: Low-income markets

- Benchmark: #Branches with current internet penetration rate in 2018



Effects on bank branches: High-income markets

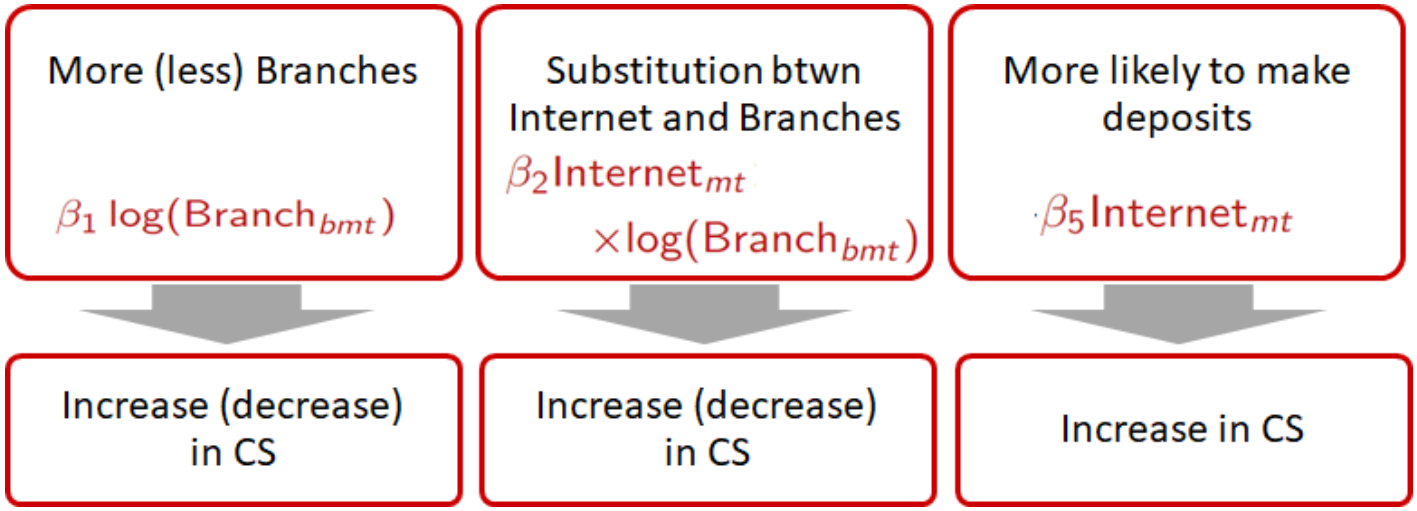
- Benchmark: #Branches with current internet penetration rate in 2018



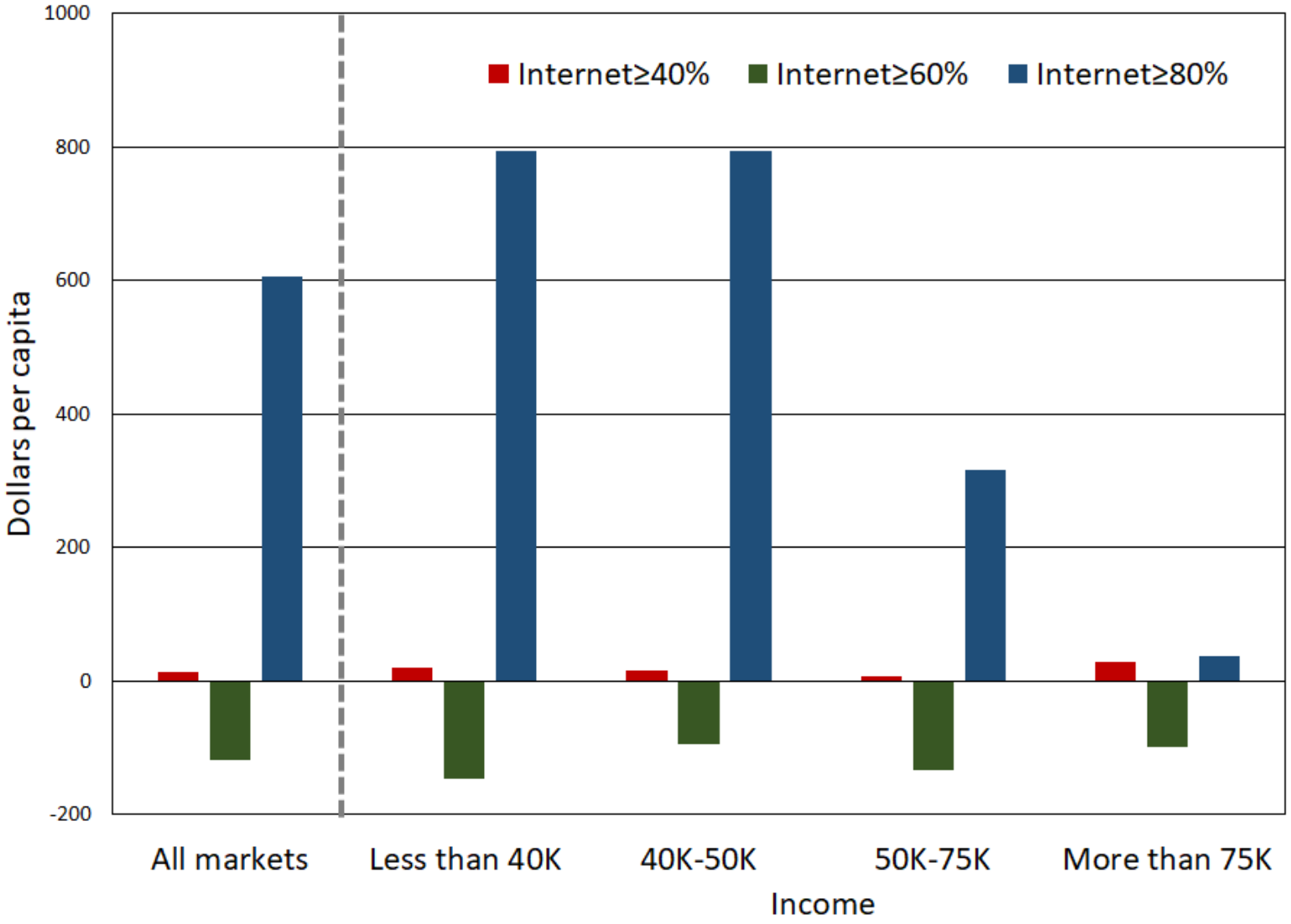
Effects of higher internet penetration on consumer welfare

- Consumer welfare does not necessarily move the same direction as the number of branches moves.
- How does a consumer's utility change when the internet penetration rate rises and thus more (less) branches in the market?

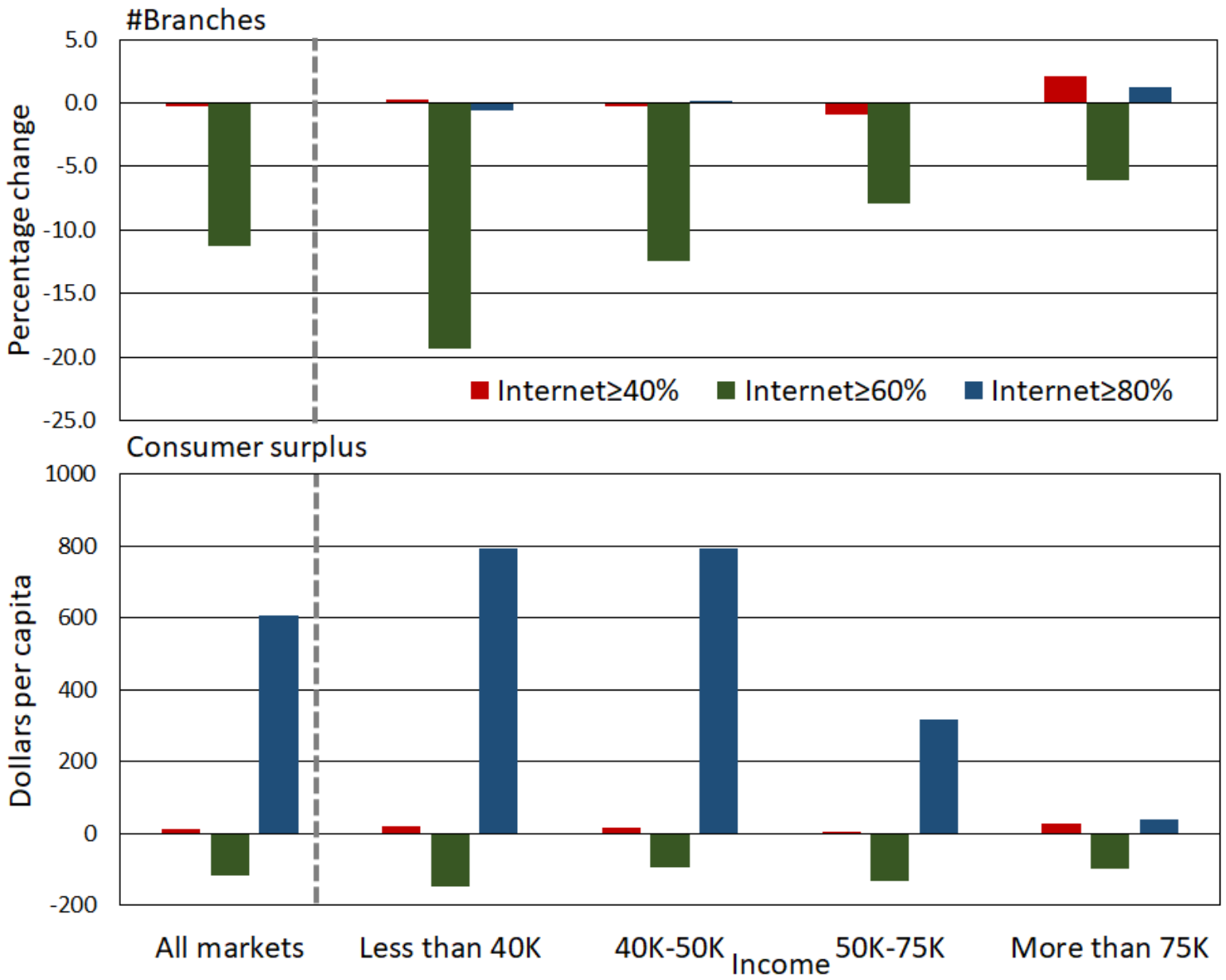
$$
\begin{aligned}
u_{ibmt} = & \alpha \text{DepR}_{bt} \times \text{Income}_{mt} + \beta_1 \log(\text{Branch}_{bmt}) + \beta_2 \text{Internet}_{mt} \times \log(\text{Branch}_{bmt}) \\
& + \beta_3 \text{Online}_{bt} \times \mathbb{1}(\text{Bank}_b) + \beta_4 \text{Website}_{bt} \times \mathbb{1}(\text{CreditUnion}_b) \\
& + \beta_5 \text{Internet}_{mt} + \beta_6 \log(\text{Income}_{mt}) + \varsigma_{igmt} + \xi_t + \xi_{bm} + \xi_{bmt} + \varepsilon_{ibmt}
\end{aligned}
$$



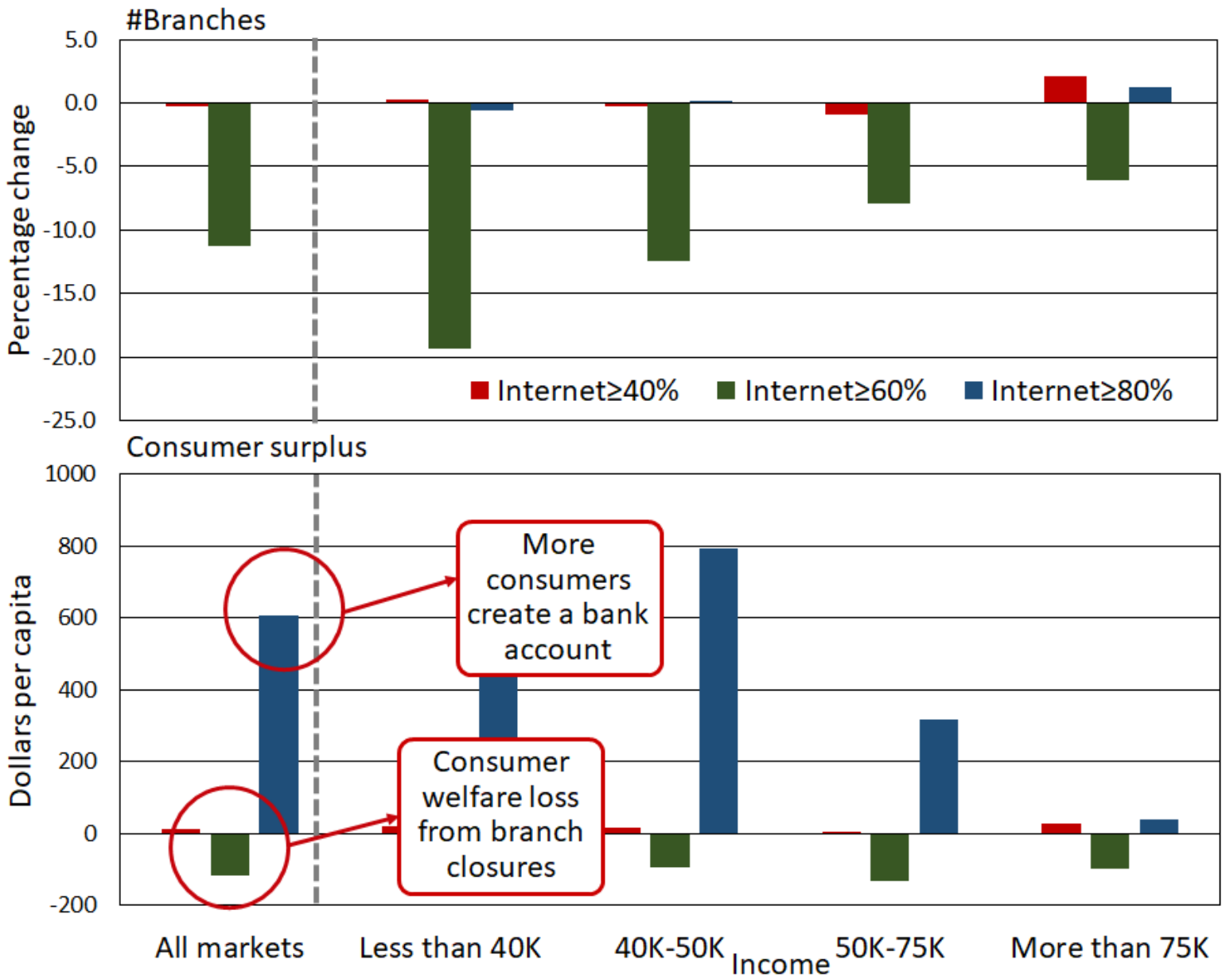
Effects of higher internet penetration on consumer welfare



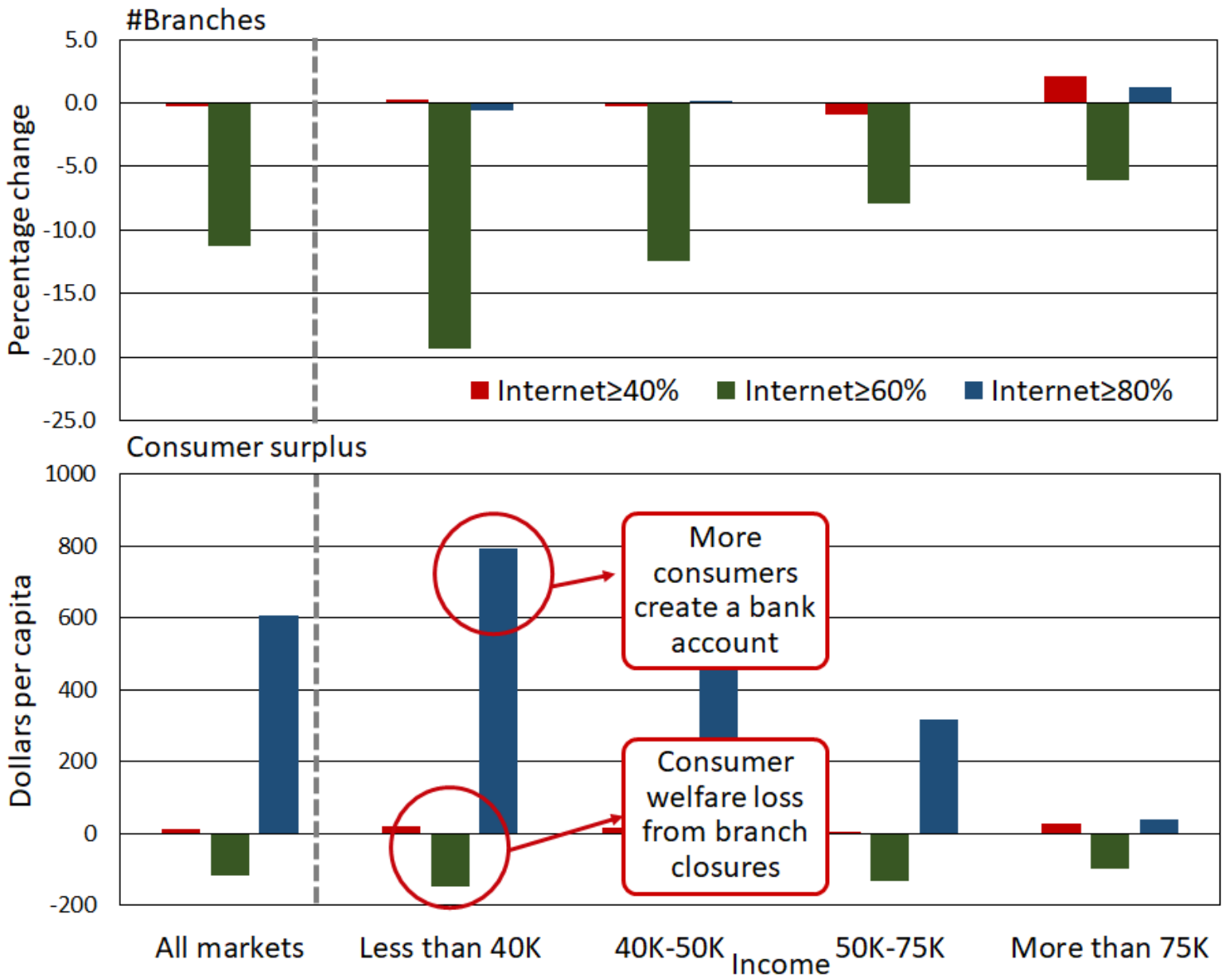
Effects of higher internet penetration on consumer welfare



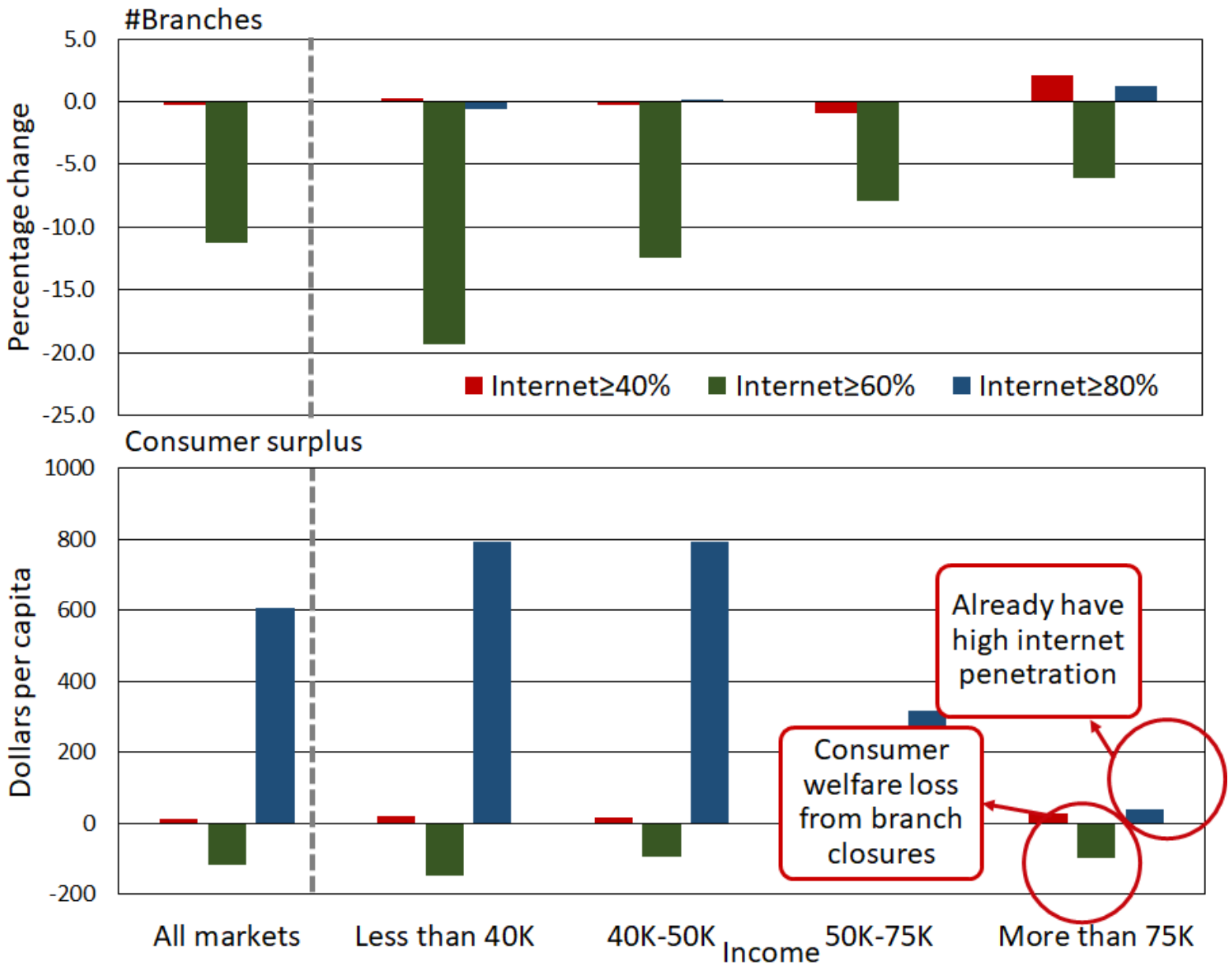
Effects of higher internet penetration on consumer welfare



Effects of higher internet penetration on consumer welfare



Effects on consumer welfare: By income



Conclusion

- How does the internet affect bank branches and consumer welfare in retail banking industry?
- The change in bank branches and consumer welfare depends on i) minimum internet penetration rate for all markets and ii) income.

	Internet ≥ 60%		Internet ≥ 80%	
	#Branches	CS	#Branches	CS
All markets	#Branches decreases by 11%.	Consumers lose $118 on average.	#Branches stays same as the current #Branches.	Consumers gain $605 on average.
Low-income markets	#Branches decreases by 19%.	Consumers lose $146 on average.	#Branches decreases by 0.5%.	Consumers gain $794 on average.
High-income markets	#Branches decreases by 6%.	Consumers lose $99 on average.	#Branches increases by 1%.	Consumers gain $38 on average.

Conclusion

- When the minimum internet penetration rate increases to 60%, the number of branches decreases and consumers experience welfare loss.

	Internet ≥ 60%		Internet ≥ 80%	
	#Branches	CS	#Branches	CS
All markets	#Branches decreases by 11%.	Consumers lose $118 on average.	#Branches stays same as the current #Branches.	Consumers gain $605 on average.
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High-income markets	#Branches decreases by 6%.	Consumers lose $99 on average.	#Branches increases by 1%.	Consumers gain $38 on average.

Conclusion

- When the minimum internet penetration rate increases to 60%, the number of branches decreases and consumers experience welfare loss.
- However, when the internet penetration rate reaches 80%, consumer surplus increases.

	Internet ≥ 60%		Internet ≥ 80%	
	#Branches	CS	#Branches	CS
All markets	#Branches decreases by 11%.	Consumers lose $118 on average.	#Branches stays same as the current #Branches.	Consumers gain $605 on average.
Low-income markets	#Branches decreases by 19%.	Consumers lose $146 on average.	#Branches decreases by 0.5%.	Consumers gain $794 on average.
High-income markets	#Branches decreases by 6%.	Consumers lose $99 on average.	#Branches increases by 1%.	Consumers gain $38 on average.

Conclusion

- Low-income markets experience more branch closures as the internet penetration rate increases.

	Internet ≥ 60%		Internet ≥ 80%	
	#Branches	CS	#Branches	CS
All markets	#Branches decreases by 11%.	Consumers lose $118 on average.	#Branches stays same as the current #Branches.	Consumers gain $605 on average.
Low-income markets	#Branches decreases by 19%.	Consumers lose $146 on average.	#Branches decreases by 0.5%.	Consumers gain $794 on average.
High-income markets	#Branches decreases by 6%.	Consumers lose $99 on average.	#Branches increases by 1%.	Consumers gain $38 on average.

Conclusion

- Low-income markets experience more welfare loss while the internet penetration rate increases, but they gain more when the internet penetration rate reaches 80%.

	Internet ≥ 60%		Internet ≥ 80%	
	#Branches	CS	#Branches	CS
All markets	#Branches decreases by 11%.	Consumers lose $118 on average.	#Branches stays same as the current #Branches.	Consumers gain $605 on average.
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Conclusion

- Policy implications: Regulations to slow down branch closures or to accelerate establishing internet connections in low-income markets

	Internet ≥ 60%		Internet ≥ 80%	
	#Branches	CS	#Branches	CS
All markets	#Branches decreases by 11%.	Consumers lose $118 on average.	#Branches stays same as the current #Branches.	Consumers gain $605 on average.
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Implications for Korean market

- Extending the model to Korean market: Higher internet penetration rate (larger substitution effect) and lower unbanked rate (smaller complementary effect)
- Predicting the effect of digitization in banking industry
- Effects of digitization in other finance industries
- Expanding the model framework of linking the demand-supply model to the entry-exit model to other markets

Thank you.