New-consumer margin at work:
Exposure to television ads as driver of smoking prevalence

Rizki Nauli Siregar
University of Mainz

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DISCLOSURE

I have no competing interests to disclose. I have not received any tobacco-related funding over the past 10 years.

Success in reducing smoking prevalence varied.

Percentage point changes in adult male smoking prevalence (2000-2015)

Legend: ■ (0,20] ■ (-4,0] ■ (-7,-4] ■ (-10,-7] ■ [-30,-10] □ No data
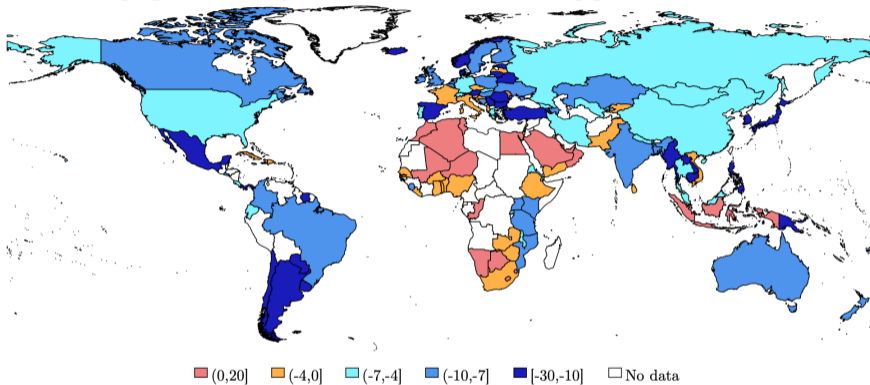
Source: WHO, author's calculation.

- Congo experienced the largest growth with 37.2 percentage points increase.
- Indonesia jumped from the 16th place in 2000 to the 2nd place with 75.2 percent smoking prevalence for adult males in 2015.

Research question

How does an improvement in marketing technology used to advertise tobacco products affect smoking prevalence?

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How does an improvement in marketing technology used to advertise tobacco products affect smoking prevalence?

Main finding and contribution

- Higher relative local exposure to televisions (TV), which proliferates the broadcasts of tobacco ads, increases smoking participation of young adults.
- The first study with nationally-representative data that focuses on the impact of marketing to smoking participation in developing country setting.

Related literature

1. The impact of introduction and proliferation of electronic media to human and social capital.
   - This paper: how exposure to advertising through TV increases smoking participation within a developing-country context, where smoking prevalence is rising.
   - Thomas (2019) on the impact of the introduction of TV to smoking prevalence in the US.
   - Olken (2009) on the impact of the introduction of private TV stations on social capital in Indonesia.

2. Smoking behavior.
   - This paper: the impact of advertising exposure to smoking participation in young adults.
   - Warner et al (1992): despite ads are not the sole determinant of smoking, it is the most tractable.
   - Chaloupka and Warner (1999) and Wellman et al (2006) for surveys.

3. The role of advertising in firm dynamics.

Theoretical Framework

The theory of marketing cost in international trade (Arkolakis, 2010)

This framework introduces a distinct new margin in welfare gains from more trade:

- **new-consumer margin** (the focus in this paper)
    - intuition: welfare gains enjoyed by new consumers; related to new smokers.
    - how exposure to advertising affects the decision to start smoking.

- **intensive margin**
    - intuition: welfare gains from an increase of consumption; related to smoking intensity.
    - to analyze this, we need to incorporate utility function that takes tobacco as an addictive substance, e.g., Thaler and Shefrin (1981), Farrell (1952), and Becker and Murphy (1988).

- **extensive margin**
    - intuition: welfare gains from new export destinations.
    - not the focus in this study as I focus on one market.

Arkolakis (2010)

Basic Environment

- Firms are heterogeneous in productivity, ϕ.

Marketing

- S is the number of advertisements (ads) sent by a firm.
- L is the number of consumer.
- $n(S)$ is the probability that a particular consumer sees the ad at least once after S ads have been sent.

▶ consumption   ▶ price

Arkolakis (2010): Marketing technology

Three assumptions on the nature of the marketing technology:

1. The number of consumers who see the ad is given by $L^{1-\alpha}$, where $\alpha \in [0,1]$.
   - $\alpha = 1$: one ad is read by one consumer, e.g., flyers.
   - $\alpha = 0$: one ad can reach a given share of consumers in a market, e.g., TV ads.
   - I refer to improvement in marketing technology as a decrease in α.

2. Decreasing return or increasing marginal cost of marketing: The probability that a new ad is seen by a consumer for the first time is $[1 - n(S)]^\beta$, with $\beta \in [0, +\infty)$.
   - Brown (1978) and Thomas (1989) show evidences that the cigarette industry faces diminishing returns in advertising.

3. Production function of marketing services: $S = l_j^\gamma l_i^{1-\gamma}$, with $0 \leq \gamma \leq 1$.
   - Firms combines labor services in the source country i, l_i, and the destination country j, l_j.

Arkolakis (2010): Equilibrium

- Firms maximize profits, which is the difference between revenue with labor cost of production and marketing cost.

- Provided that the firm enters the market, i.e., $\phi \geq \phi_{ij}^*$, where ϕ_{ij}^* is the entry threshold, there exist an optimal share of consumers to be reached, n_{ij}.

▸ MR = MC   ▸ entry threshold

Arkolakis (2010): Proposition on optimal market penetration

If marketing technology is subject to diminishing returns, i.e., $\beta > 0$, then there exists entry threshold ϕ_{ij}^*, such that:

$$\phi \leq \phi_{ij}^* \;\Rightarrow\; n_{ij} = 0, \qquad \text{and} \tag{1}$$

$$\phi_1 > \phi_2 \geq \phi_{ij}^* \;\Rightarrow\; n_{ij}(\phi_1) \geq n_{ij}(\phi_2) \tag{2}$$

▸ proposition   ▸ market penetration

What matters to optimal market penetration

productivity growth   **marketing technology**

price

... get comparative statics of ϕ for productivity growth, and

... get comparative statics of α for marketing technology.

Productivity growth

- Conditional on entering the market, a more productive firms has higher optimal market share.

- The change in optimal market share due to an increase in productivity:

$$\frac{\partial n_{ij}}{\partial \phi} > 0 \tag{3}$$

- If the firm faces diminishing returns marketing technology, i.e., $\beta > 0$, then an increase in productivity ϕ, increases the firm's optimal market penetration n_{ij}.

▸ equation

Marketing Technology

- Conditional on passing the entry threshold, the impact of changes in α to the optimal market penetration, n_{ij}, is:

$$\frac{\mathrm{d}n_{ij}(\phi_{ij}^*)}{\mathrm{d}\phi_{ij}^*}\frac{\mathrm{d}\phi_{ij}^*}{\mathrm{d}\alpha} < 0 \tag{4}$$

- Hence, as it gets easier to reach more consumers per ad, or as α declines, then the optimal market penetration, n_{ij}, increases.

▸ equation

Empirical Facts:
Smoking Environment in Indonesia

Smoking environment in Indonesia: Tobacco consumption

- Indonesia has one of the highest smoking prevalence in adult males.
    - 75.2% in 2015 (WHO)
    - 46.7% in 2015 (GBD 2015 Tobacco Collaborators)

- Smoking participation is more common among males.
    - Female: 3.8% in 2015 (GBD 2015 Tobacco Collaborators)

- Tobacco products contribute the third biggest share in households' consumption basket. ▸ details
    - Spending on tobacco products constitutes at least twice of spending on health services.

- There is substantial variation in smoking prevalence across regions in Indonesia.
▸ regional smoking prev.

Smoking environment in Indonesia: Tobacco industry

- The tobacco manufacturing industry is not a new industry in Indonesia, established in early 20th century.

- The industry has many small firms with a few large firms.

- The three biggest firms account for more than 70% of the market share (Setyonaluri et al., 2008).

- Most of tobacco manufacturers, including the foreign-owned ones, sell domestically.

- Imports are rather small: $\sim$ 0.5%-0.6% relative to domestic cigarette productions (Ibid.)

Theory to empirics

We can collect two parameters and one variable that may affect optimal market shares:
- marketing technology
- productivity
- price

Context: smoking environment in Indonesia from 1990 to 2010.

**Fact 1**: Exposure to marketing through television has expanded and varied spatially.

Fact 2: Industry's average productivity has been relatively stagnant.

Fact 3: Real prices of cigarettes has been relatively stagnant.

▸ Fact 1   ▸ Fact 2   ▸ Fact 3

Fact 1: Exposure to marketing through television has expanded and varied spatially.
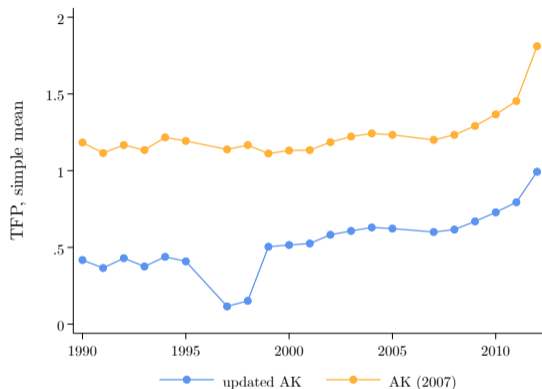
- Before 1993, there was only one state-owned TV station, which does not broadcast ads.
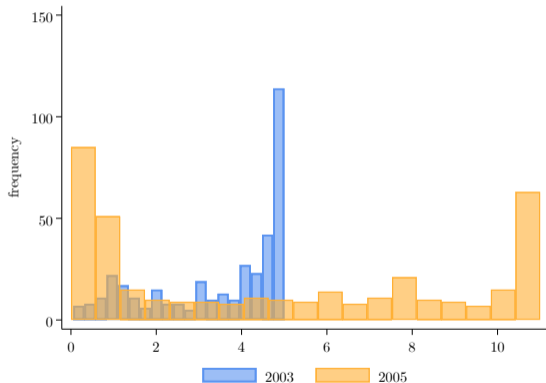
Source: Village Census, author's calculation
Notes: The horizontal axis shows the district-average number of private TV stations received in villages.

# Fact 2: Industry's average productivity has been relatively stagnant.

Source: Manufacturing Survey and author's calculation.
Notes: AK (2007) refers to estimated productivity using production function coeffi-cients as in Amiti and Koning (2007). Updated AK refers to author's update on pro-ductivity estimation following Amiti and Koning (2007).

Fact 3: Real prices of cigarettes has been relatively stagnant.

Observed real price of cigarettes spent by households
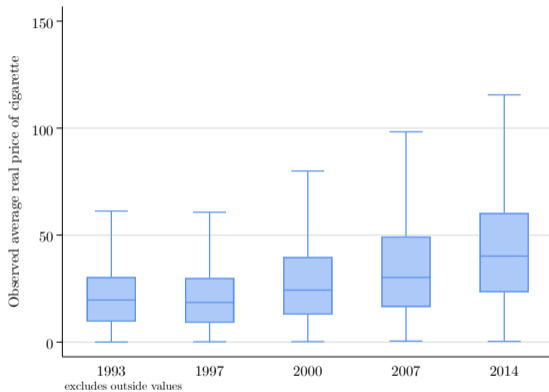
Source: IFLS, author's calculation

Substantial tax hike happened in 2008 (Setyonaluri et al., 2008)

▸ back

Empirical context

Tobacco policies:

- Indonesia has not ratified WHO FCTC.
- Regulations for advertising on electronic media began in 2000: tobacco ads can only be aired on TVs between 9:30 pm to 5 am local time.
- No minimum age regulation before 2012.
- Pictorial health warnings are required since 2012.
- Limited local governments regulations.

. . .The Indonesian economy in the 2000s is an appropriate context to study the impact of an increase in advertising exposure to smoking prevalence.

Data and Empirical Strategy

Data

- **Indonesia Family Life Survey (IFLS)**
    - coverage: represents 83% of Indonesia's population, >90% recontact rate.
    - waves included: 2000 and 2007
    - outcome of interest: smoking participation
    - individual and household heads' socio-economic variables.

- **Village Census (*Podes*)**
    - coverage: the universe of villages, the lowest administrative units in Indonesia
    - period included: 2003 and 2005/2006
    - variable of interest: number of TV channels reception

Empirical Strategy: focus on the new-consumer margin

Selection criteria:
- IFLS waves: 2000 and 2007
- Age: 17-23 years old
- Not a household heads (included in the robustness checks)

TV signal reception:
- I follow Olken (2009) who shows that local reception is not entirely driven by the endogenous decision of placing TV towers, but also determined exogenously by geographical features such as terrain and topography.
- This paper: exploit the temporal and regional variation in *relative* intensity of exposure to televisions.

TV ads as improvement in marketing technology

The variable of interest: TV_{st}

- Computed as the standardized-value of the average number of TV channels received for each subdistrict s.
- Subdistrict is the next higher administrative level above the village level.
- An increase in this variable $\Rightarrow$ a decrease of α, i.e., one unit of TV ads can reach a bigger fraction of a population.
- The impact is perceived as a general effect of broadcast media (Olken, 2009).

▸ Fact 1

Empirical strategy

$$Smoke_{icst} = \alpha + \sum_c \beta_c TV_{st} \cdot \mathbb{I}_c + \mathbb{X}_{icst} + \delta_c + \delta_{prov} + \delta_t + \delta_{prov} \times \delta_t + \epsilon_{icst} \tag{5}$$

where:

- $Smoke_{icst}$: is whether individual i, with age cohort c, living in subdistrict s, from survey wave t, smokes or not. It is 1 if the person smokes, and 0 otherwise.
- TV_{st}: relative exposure to ads through TV.
- $\mathbb{X}_{icst}$: individual controls (such as school attendance, education attainment, etc.) and household head's controls (such as smoking participation, education, real income, etc).
- δ_c: age fixed effects
- δ_{prov}: province fixed effects
- δ_t: time (IFLS wave) fixed effects
- ϵ_{icst}: idiosyncratic errors

Results

Evidence of the new-consumer margin

Dependent variable: smoking

	(1)	(2)	(3)	(4)	(5)	(6)
TV channels, std	0.003	0.018	0.018	0.016	0.037*	0.037*
	(0.008)	(0.012)	(0.012)	(0.013)	(0.023)	(0.023)
age=18 x TV		-0.001	-0.001		0.012	0.012
		(0.017)	(0.017)		(0.030)	(0.030)
age=19 x TV		-0.007	-0.007		0.018	0.018
		(0.019)	(0.019)		(0.032)	(0.032)
age=20 x TV		-0.007	-0.007		-0.043	-0.043
		(0.019)	(0.019)		(0.033)	(0.033)
age=21 x TV		-0.033*	-0.033*		-0.065**	-0.065**
		(0.018)	(0.018)		(0.031)	(0.031)
age=22 x TV		-0.039**	-0.039**		-0.062*	-0.062*
		(0.019)	(0.019)		(0.032)	(0.032)
age=23 x TV		-0.027	-0.027		-0.044	-0.044
		(0.018)	(0.018)		(0.033)	(0.033)
N	8251	8251	8251	3557	3557	3557
Sample	all	all	all	male	male	male
Province x Wave	X	X	X	X	X	X
Price x Province			X			X

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Impacts are heterogeneous across age.

|	Slope	
	TV channels, std	TV channels
main		
age = 17	0.037*	0.012*
	(0.023)	(0.006)
age = 18	0.049**	0.011
	(0.025)	(0.007)
age = 19	0.056**	0.013*
	(0.027)	(0.007)
age = 20	-0.005	0.001
	(0.028)	(0.007)
age = 21	-0.028	-0.000
	(0.025)	(0.007)
age = 22	-0.024	-0.005
	(0.027)	(0.008)
age = 23	-0.007	-0.001
	(0.028)	(0.007)
Observations	3557	3557

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table: Marginal effect of exposure to TVs on smoking participation
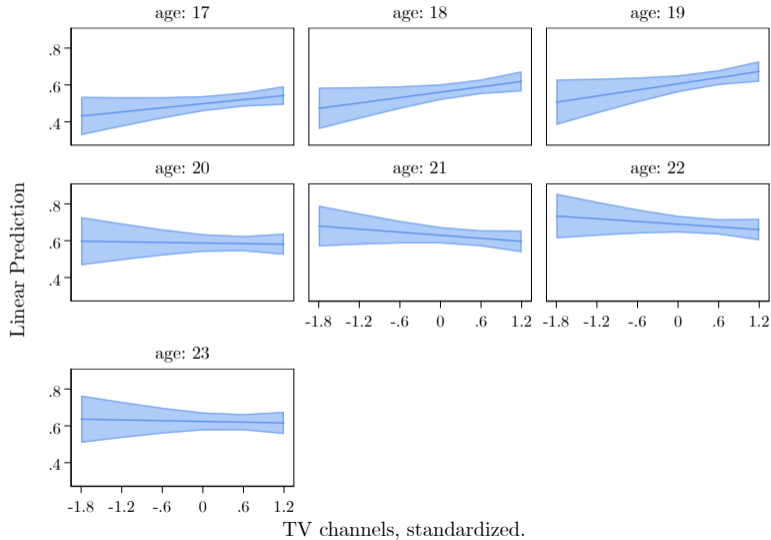
Average smoking participation across age.

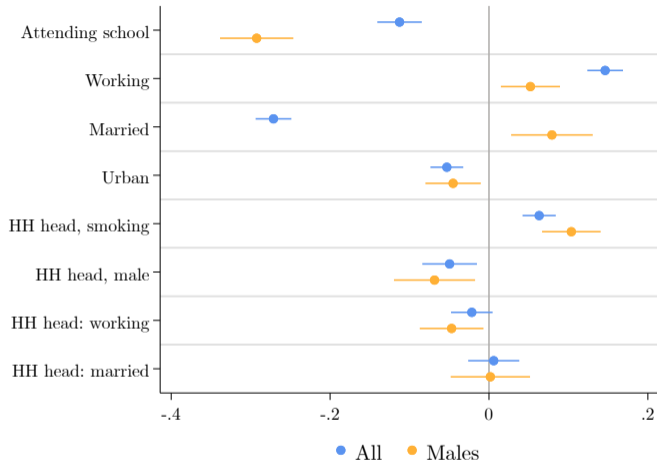Coefficient estimates for age fixed effects to smoking participation in 17-23 years old
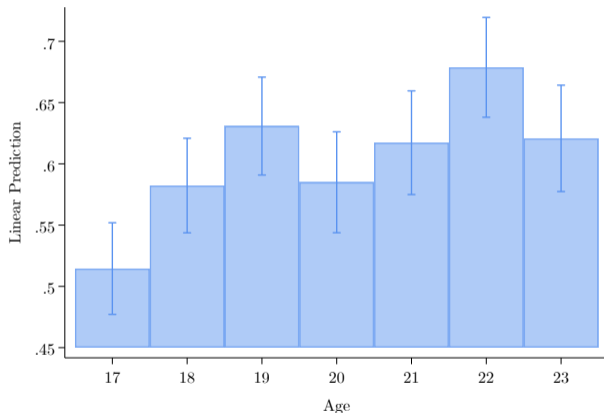
Notes: The ranges show the 95% confidence interval of the estimated coefficients.

Marginal impacts of TV exposure to smoking participation by age

TV channels, standardized.

Estimates of control variables on smoking

Notes: The 95% confidence intervals for coefficient are shown by the range plots.

▸ educ_inc

Long-run Impacts

Empirical strategy

- outcome variables: college-degree attainment, working status
- empirical estimation: instrumenting smoking status 7 years later with smoking status during adolescent.

Results:

- Individuals who smoke have a lower probability of possessing a college degree.
  ▸ LR: college
- The impact of smoking on working status is not as conclusive. ▸ LR: work

Conclusions

- I investigate the theoretical prediction that improvement in marketing technology generates new consumer.

- I test the prediction by estimating the impact of exposure to TVs, representing ads through broadcast media, on smoking prevalence among young adults in Indonesia between 2000 and 2007.

- As predicted, higher relative local exposure to TV generates more smokers especially those of 17-19 year old males.

# Policy Implications

- The result stands in contrast to the argument that the purpose of tobacco ads is to strengthen branding, i.e., affecting only smoking intensity.

- As many developing economies have a higher share of the young population, advertising efforts of tobacco companies in such economies would have bigger macro consequences.

Thank you!

Contact:
rsiregar@uni-mainz.de
rizkisiregar.org

Smoking prevalences have gone down globally.
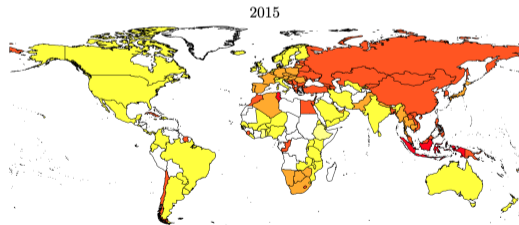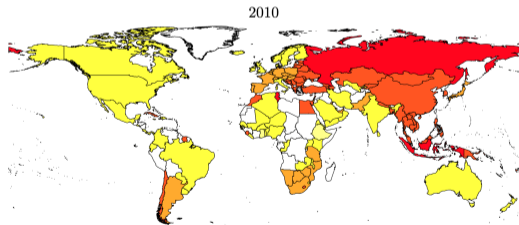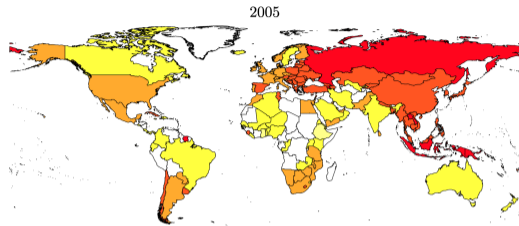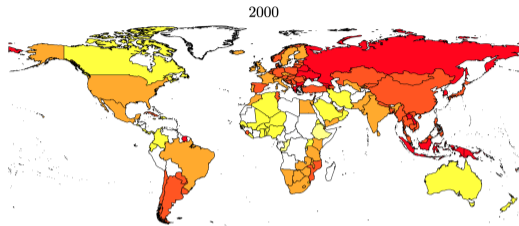
The cutoffs are: [0, 10], (10, 30], (30, 40], (40, 60], (60, 80].

Fact 2: Industry's average TFP has been relatively stagnant.
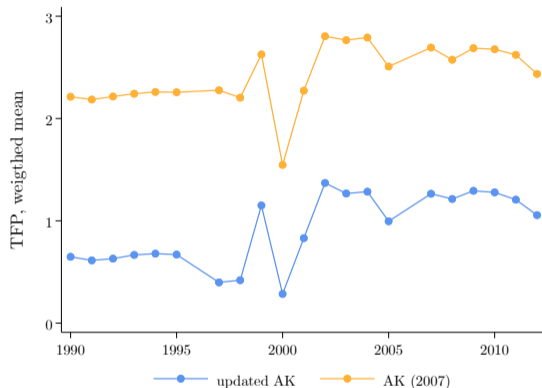
Source: Manufacturing Survey and author's calculation.
Notes: AK (2007) refers to estimated TFP using production function coefficients as in Amiti and Koning (2007). Updated AK refers to author's update on TFP estimation following Amiti and Koning (2007).

Fact 2

Long-run impact: college-degree

<div align="center">

Dependent var.: College-degree attainment

	(1)	(2)	(3)	(4)
Smoking	-0.089***	-0.128**	-0.076***	-0.112***
	(0.025)	(0.051)	(0.024)	(0.040)
N	1208	1208	1147	1147
Wave	2000	2000	2007	2007
Model	OLS	IV	OLS	IV

</div>

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes individuals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are male and not household heads.

Long-run impact: working status

Dependent var.: Working status

	(1)	(2)	(3)	(4)
Smoking	-0.016	-0.088**	-0.015	-0.045
	(0.019)	(0.040)	(0.024)	(0.040)
N	1208	1208	1147	1147
Wave	2000	2000	2007	2007
Model	OLS	IV	OLS	IV

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes individuals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are male and not household heads.

▸ back

Arkolakis (2010): Price

Optimal Price

- Firms operate using CRS technology with productivity ϕ.
- Labor is the only factor of production.
- Firms face iceberg trade costs, τ_{ij}, in selling to overseas market.
- Hence, the optimal pricing is:

$$p_{ij}(\phi) = \frac{\sigma}{\sigma - 1} \frac{\tau_{ij} w_i}{\phi} \tag{6}$$

▸ environment

Arkolakis (2010): Consumption

Consumer

- A consumer in country j consumes a composite good from combining differentiated commodities using CES aggregator with elasticity of substitution $\sigma > 1$.
- She receives income y_j, from her labor income, w_j, and profits earned, ϕ_j.
- Hence, the demand for each variety as a function of productivity, ϕ,:

$$c_{ij}(\phi) = \frac{p_{ij}(\phi)^{-\sigma}}{P_j^{1-\sigma}} y_j \tag{7}$$

where p_{ij} is the price of that variety and P_j is the price index for all variety consumed in market j.

▸ environment

Arkolakis (2010): Equilibrium

- Firms maximize profits, which is the difference between revenue with labor cost of production and marketing cost.
- Provided that the firm enters the market, i.e., $\phi \geq \phi_{ij}^*$, where ϕ_{ij}^* is the entry threshold, the optimal consumers to be reached, n_{ij}, solves:

$$\frac{y_j}{\sigma} \frac{\left[\tilde{\sigma}(\tau_{ij} w_i / \phi)\right]^{1-\sigma}}{P_j^{1-\sigma}} = \frac{w_j^{\gamma} w_i^{1-\gamma}}{\psi L_j^{1-\sigma}} \frac{1}{(1-n_{ij})^{\beta}} \tag{8}$$

where:

- $\tilde{\sigma} = \frac{\sigma}{\sigma-1}$ is the constant mark-up,
- $\frac{1}{\psi} = \gamma^{\gamma}(1-\gamma)^{1-\gamma}$ is the per-unit advertisement costs.

Arkolakis (2010): entry threshold ϕ_{ij}^*

Solving eq (8) for ϕ by setting $n_{ij} = 0$, we can derive the entry threshold ϕ_{ij}^*:

$$\left(\phi_{ij}^*\right)^{\sigma-1} = w_j^\gamma w_i^{1-\gamma} L_j^{\alpha-1} / \left[\frac{y_j}{\sigma}\frac{(\tilde{\sigma}t_{ij}w_i)^{1-\sigma}}{P_j^{1-\sigma}}\psi\right] \tag{9}$$

where:

- $\tilde{\sigma} = \frac{\sigma}{\sigma-1}$ is the constant mark-up,
- $\frac{1}{\psi} = \gamma^\gamma(1-\gamma)^{1-\gamma}$ is the per-unit advertisement costs.

Arkolakis (2010): Proposition on optimal market penetration

- If marketing technology is subject to diminishing returns, i.e., $\beta > 0$, then there exists entry threshold ϕ_{ij}^*, such that:

$$\phi \leq \phi_{ij}^* \;\Rightarrow\; n_{ij} = 0, \qquad \text{and} \tag{10}$$

$$\phi_1 > \phi_2 \geq \phi_{ij}^* \;\Rightarrow\; n_{ij}(\phi_1) \geq n_{ij}(\phi_2) \tag{11}$$

- If marketing technology is not subject to diminishing returns, i.e., $\beta = 0$, then there exists entry threshold ϕ_{ij}^*, such that:

$$\phi \leq \phi_{ij}^* \;\Rightarrow\; n_{ij} = 0, \quad \text{and} \tag{12}$$

$$\phi > \phi_{ij}^* \;\Rightarrow\; n_{ij}(\phi) = 1 \tag{13}$$

Arkolakis (2010): Optimal market penetration

Inverting eq (8) to solve for $n_{ij}(\phi)$ where $\phi \geq \phi_{ij}^*$, and using the equation for entry threshold (9), the optimal market penetration choice of a firm for $\beta \geq 0$ as a function of ϕ and ϕ_{ij}^*:

$$n_{ij}(\phi) = \max\left\{1 - \left(\frac{\phi_{ij}^*}{\phi}\right)^{(\sigma-1)/\beta}, 0\right\} \tag{14}$$

▸ proposition

Productivity growth

- If the firm faces diminishing returns marketing technology, i.e., $\beta > 0$, then an increase in productivity ϕ, increases the firm's optimal market penetration n_{ij}.

- Differentiating the first term in (14) with respect to ϕ:

$$\frac{\partial n_{ij}}{\partial \phi} = \frac{\sigma - 1}{\beta} \left(\frac{\phi_{ij}^*}{\phi} \right)^{\frac{\sigma - \beta - 1}{\beta}} > 0 \tag{15}$$

- Hence, conditional on entering the market, a more productive firms has higher optimal market share.

Marketing Technology

- Conditional on passing the entry threshold, the impact of changes in α to the optimal market penetration, n_{ij} is:

$$\frac{\mathrm{d}n_{ij}(\phi_{ij}^*)}{\mathrm{d}\phi_{ij}^*}\frac{\mathrm{d}\phi_{ij}^*}{\mathrm{d}\alpha} = -\frac{\ln\phi_{ij}^*}{\beta\phi}\left(\phi_{ij}^*\right)^{\frac{\sigma-1}{\beta}} < 0 \tag{16}$$

- Hence, as it gets easier to reach more consumers per ad, or as α declines, then the optimal market penetration, n_{ij}, increases.

Households consumption basket

Percentages of average per capita monthly expenditure by commodity groups

Commodity group	2000		2010		2015	
	urban	rural	urban	rural	urban	rural
Rice and other cereals	11.97	20.89	6.24	13.07	5.53	11.59
Tobacco products	5.67	8.29	4.39	6.61	5.12	8.40
Education costs	4.89	2.11	4.38	2.48	4.59	2.77
Health costs	2.10	1.76	2.79	2.47	3.36	3.17

Source: Statistik Indonesia 2001, 2011, and 2016.

▸ context: consumption

Smoking prevalence for population of 15 years or older across districts (2016)
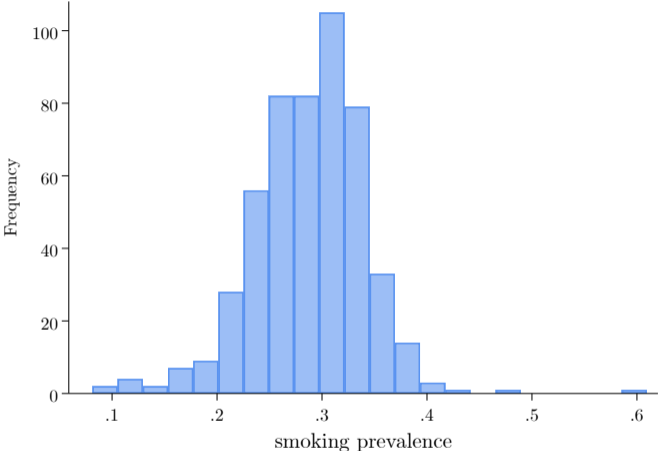
Source: Susenas 2016, author's calculation.

context: consumption

Estimates for education and income

Dependent var: smoking

	(1)	(2)	(3)	(4)	(5)	(6)
Education	0.001	0.001	0.001	-0.005**	-0.005**	-0.005**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
HH head, education	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
HH head, income	-0.000**	-0.000**	-0.000**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	8251	8251	8251	3557	3557	3557
Sample	all	all	all	male	male	all
TV x Age		X	X		X	X
Province x Wave	X	X	X	X	X	X
Price x Province			X		X	X

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes inviduals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are not household heads. All specifications include age fixed effects, province fixed effects, and survey wave fixed effects. Robust standard errors are used.

▸ controls