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Presentation

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January, 2018

Introduction

- Income and wealth inequality have been rising in many developed countries (Piketty, 2014)
- At the same time, productivity growth has slowed down
  - Gordon (2016) attributes it to decreasing returns to innovation
- **Research question**: How does inequality affect the incentives to innovate by affecting the demand for new goods?
- **Motivating stylized fact:** richer households purchase a larger variety of goods than poorer ones (Jackson, 1984; Falkinger and Zweimüller, 1996)
  - Also holds for selected "innovative goods" more here

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- **This paper**: Model with non-homothetic preferences (based on Föllmi and Zweimüller, 2016) in which richer households purchase a larger variety of goods than poorer ones.
  - **Market size effect**: how many households purchase a new good?
  - **Price effect**: how high is the willingness to pay of a household for a new good?
- **Main results**:
  - Inequality is more likely to encourage innovation when the size of the population is large (for a given total income).
  - Inequality is more likely to discourage innovation when innovations become more incremental (easily substitutable).
- Extend model to study **patent subsequent filings in multiple countries** and show that they depend in the same qualitative way on inequality in the destination countries as innovation depends on inequality in the basic model.

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- **Challenge:** In a globalized economy, the incentives to innovate not only depend on local market conditions and local inequality, but also on the foreign demand for innovations.
- **Empirical strategy:** We use data from PATSTAT and analyze how patent flows towards a country depend on inequality in this country
- An applicant with a registered priority filing is likely to only file for subsequent patent protection in a country if the corresponding market is profitable enough to justify paying the fixed costs of the subsequent filing.
- As patent flows and innovation depend in the same qualitative way on inequality in our model, we think that empirically analyzing how patent flows depend on inequality allows us to understand how innovation depends on inequality (in a qualitative way).
- Our empirical results are in line with the model's key predictions

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Model Setup (closed economy)

- **Utility** of household i:

$$U_i = f(C_i) + G_i$$

  - $C_i = \int_{j=0}^{N} c_{ij} dj$: variety of **innovative goods** consumed (N: measure of invented innovative goods).
  - *Assumptions*: $c_{ij} \in \{0; 1\}$; $\frac{\partial f(C)}{\partial C} > 0$; $\frac{\partial^2 f(C)}{\partial C^2} < 0$; and $\left.\frac{\partial f(C)}{\partial C}\right|_{C=0} = 1$
  - G_i: quantity of **non-innovative goods** consumed

- **Production**:
  - Producing one unit of an innovative (non-innovative) good requires c ($\Omega > c$) units of labor
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  - $C_i = \int_{j=0}^{N} c_{ij} dj$: variety of **innovative goods** consumed (N: measure of invented innovative goods).
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  - Producing one unit of an innovative (non-innovative) good requires c ($\Omega > c$) units of labor
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Market Structure and Distribution

- Innovations are granted patents; technologies for non-innovative goods are in public domain.
- Labor markets are competitive; free entry into R&D.
- Timing: $t = 0$: innovation; $t = 1$: production and consumption
- Total labor endowment (in efficiency units): Y;
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Equilibrium

- Households purchase all goods where the prices lie below their willingness to pay
- As non-innovative goods are substitutes to innovative goods, innovators are constrained in their price setting power.
- In equilibrium only households that are rich enough to purchase all innovative goods also purchase non-innovative (service) goods
    - Results are similar in an extended model with non-innovative basic need goods

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The effect of inequality on innovation

Proposition 1

An increase in inequality resulting from a regressive income transfer is more likely to increase the number of innovations N (and less likely to decrease N) the larger the size of the population L and the limit price parameter Ω are, and the smaller total income Y is.

Intuition: Free entry condition: (Price-marginal cost)(market size)=F

- When L increases, a firm charging a given price needs to sell to a lower fraction of households in order to break even
- When innovations become more incremental due to a fall in Ω or a rise in Y, innovators have to charge lower prices and need to sell to more households in order to break even.

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International Context

- There are many countries and two types of fixed costs:
  - **Inventing** a good costs R (in any country)
  - Obtaining **patent protection** in country s and transferring a technology to country s costs F_s.
- **Parallel trade** is prohibited for patented innovations
- In equilibrium, there are **frontier countries** in which innovation takes place and **adopting countries** in which just a fraction of the global innovations are protected.

Proposition 2

The probability ϕ_{jkl} that an innovative good j invented (or first patented) in country k is patented (adopted) in country l is more likely to increase (and less likely to decrease) in the level of inequality I_l in country l the larger the population size L_l and the limit price parameter Ω_l are and the lower total income Y_l is.

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- Patent priority and subsequent filings as arising from innovation i filed in country k for the first time and subsequently filed in country l at time t (k, l, and t are fixed whereas index i tends to infinity)
- Patents with priority year 1980-2015 (about 4 Mio.), covering 52 priority patent offices, and 52 subsequent patent offices (EU27 + OECD + BRICS)
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Theoretically induced hypotheses

- Positive interaction of inequality with population size
- Negative interaction of inequality and GDP

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Econometric Framework

- Aim is to estimate a conditional expectation for the aggregate variable
- $\mathbb{E}(Q_{jklt} | c_{jklt} \in_C jklt) = g(\eta_{jklt})$ with $\eta_{jklt} = \delta_j + \delta_k + \delta_l + \delta_t + z_{jklt}^T \gamma + x_{lt}^T \beta$ where
  - Q_{jklt} are aggregated filings with SITC codes j subsuming single filings i and summing over all $iklt$ constellations for each fixed klt with $i \in j$
  - δ_k, δ_l, δ_j, δ_t are fixed effects
  - x_{lt} containing the variables of interest, namely Inequality*log(POP), Inequality*log(GDP)
  - z_{jklt} containing further control variables
- Robust estimation with Quasi-Poisson model (QMLE results apply, even if conditional distribution of the dependent variable is misspecified)

Econometric Framework

- Aim is to estimate a conditional expectation for the aggregate variable
- $\mathbb{E}(Q_{jklt}|c_{jklt} \in_C jklt) = g(\eta_{jklt})$ with $\eta_{jklt} = \delta_j + \delta_k + \delta_l + \delta_t + z_{jklt}^T \gamma + x_{lt}^T \beta$ where
  - Q_{jklt} are aggregated filings with SITC codes j subsuming single filings i and summing over all $iklt$ constellations for each fixed klt with $i \in j$
  - δ_k, δ_l, δ_j, δ_t are fixed effects
  - x_{lt} containing the variables of interest, namely Inequality*log(POP), Inequality*log(GDP)
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Explanatory Variables

- Inequality: GINI pre- and post-tax (SWIID; Solt 2016), top-10%, -5%, and -1% income shares (WID; Piketty et al.)
- Measures of population and real GDP from IMF and WDI
- Measure of patent protection: Ginarte-Park-Index (latest version available until 2010), linear interpolation to obtain yearly data (original data: 5-year intervals)
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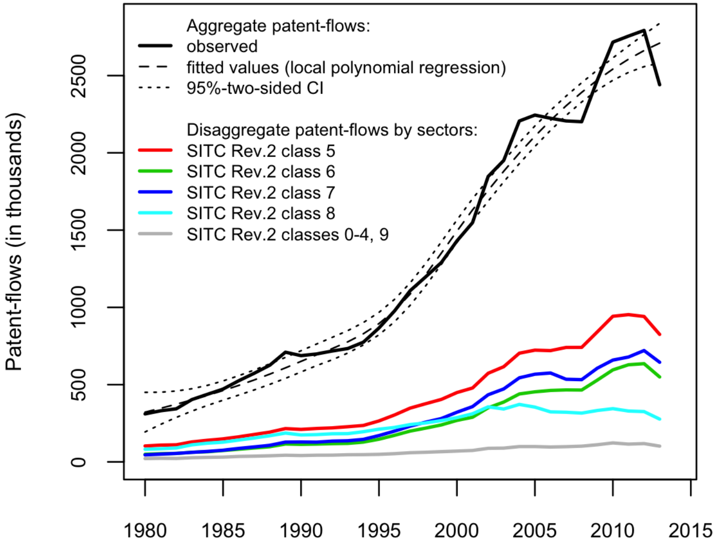
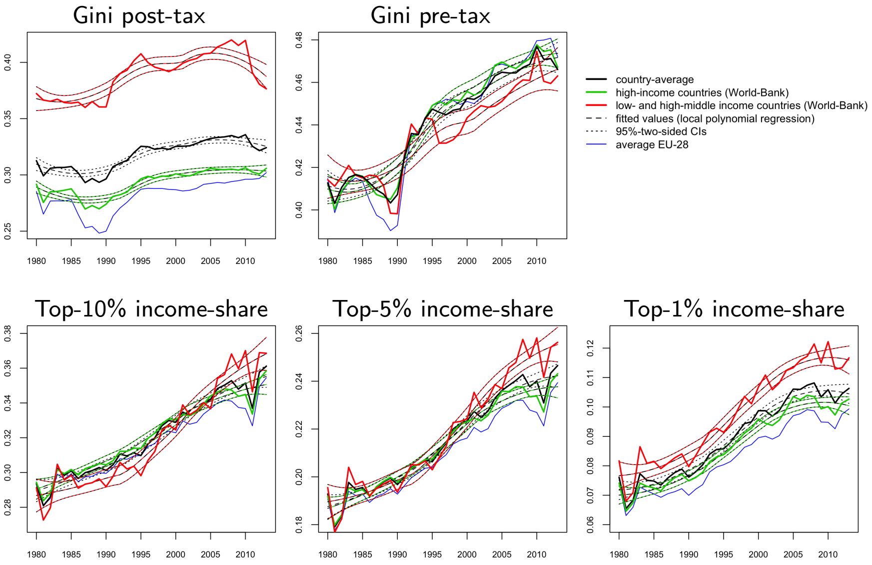
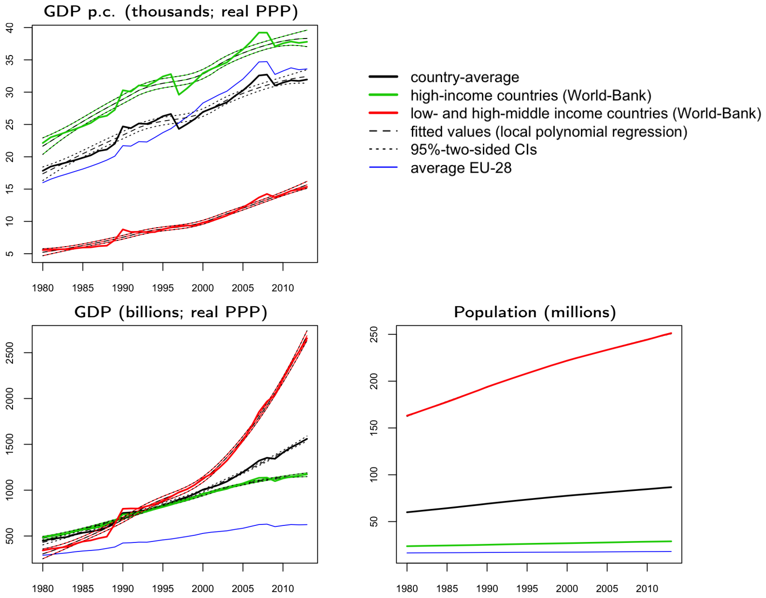
Aggregate International Priority and Subsequent Filings from 1980–2013



Average Inequality over Time



Average GDP and Population over Time



Results: Country-Pair-Year Aggregate Data

Inequality measure: [(1)/(2)]	Gini post-tax	Gini pre-tax	Top-10% income-share	Top-5% income-share	Top-1% income-share
$\log(POP_{lt})$*$INEQUALITY_{lt}$	$3.85^{***/*}$	$4.56^{***/***}$	2.20	3.33	4.41
$\log(GDP_{lt})$*$INEQUALITY_{lt}$	$-5.20^{***/**}$	$-7.87^{***/***}$	$-5.17^{**/}$	$-6.48^{**/}$	$-7.86^{**/}$
$INEQUALITY_{lt}$	$17.20^{***/**}$	$33.92^{***/***}$	$32.70^{***/**}$	$38.73^{***/*}$	$42.76^{***/*}$
$\log(POP_{lt})$	$-4.78^{***/***}$	$-5.46^{***/***}$	$-4.06^{***/***}$	$-4.01^{***/***}$	$-3.76^{***/***}$
$\log(GDP_{lt})$	$3.81^{***/***}$	$5.23^{***/***}$	$3.26^{***/**}$	$2.91^{***/**}$	$2.31^{***/***}$

Note: Estimation sample covers 46,069 country-pair-year observations. The dependent variable is aggregate patent-flows from country k to country l in year t. Estimation results derived from Quasipoisson regression with unconditional fixed-effects for origins, destinations, and years.

[(1)/(2)] inference based on (1) clustering on country-pair and on (2) three-way-clustering on origins, destinations, and years. ***, ** , and * indicate significance at 0.01, 0.05, and 0.1, respectively.

Results: Country-Pair-Year Aggregate Data

Inequality measure: $[^{(1)}/^{(2)}]$	Gini post-tax	Gini pre-tax	Top-10% income-share	Top-5% income-share	Top-1% income-share
$\log(POP_{lt})$*$INEQUALITY_{lt}$	$5.86^{***/***}$	$7.39^{***/***}$	$7.24^{***/**}$	$9.34^{***/**}$	$12.34^{***/**}$
$\log(GDP_{lt})$*$INEQUALITY_{lt}$	$-6.07^{***/***}$	$-10.12^{***/***}$	$-9.39^{***/*}$	$-11.42^{***/***}$	$-14.17^{***/**}$
$INEQUALITY_{lt}$	$18.49^{***/**}$	$40.02^{***/***}$	$44.76^{***/***}$	$52.70^{***/***}$	$60.14^{***/**}$
$\log(POP_{lt})$	$-6.99^{***/***}$	$-8.36^{***/***}$	$-7.64^{***/***}$	$-7.26^{***/***}$	$-6.42^{***/***}$
$\log(GDP_{lt})$	$5.63^{***/***}$	$8.04^{***/***}$	$6.47^{***/***}$	$5.80^{***/***}$	$4.66^{***/***}$
$RELSIZ_{klt}$	$8.17^{***/***}$	$9.48^{***/***}$	$9.86^{***/***}$	$9.68^{***/***}$	$9.29^{***/***}$
$RELTRADEOPEN_{klt}$	$-0.57^{**/}$	$-0.43^{*/}$	$-0.47^{*/}$	$-0.49^{*/}$	$-0.49^{*/}$
$COMLANG_{kl}$	0.01	0.01	0.01	0.01	0.01
$\log(DIST_{kl})$	$-0.20^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$
$GP\text{-}INDEX_{lt}$	$0.27^{***/**}$	$0.24^{***/*}$	$0.18^{**/}$	$0.20^{**/}$	$0.22^{***/}$

Note: Estimation sample covers 46,069 observations. The dependent variable is aggregate patent-flows from country k to country l in year t. Estimation results derived from Quasipoisson regression with unconditional fixed-effects for origins, destinations, and years. $[^{(1)}/^{(2)}]$ inference based on (1) clustering on country-pair and on (2) three-way-clustering on origins, destinations, and years. ***, **, and * indicate significance at 0.01, 0.05, and 0.1, respectively.

Results: Disaggregate Data (SITC 1 digit)

Inequality measure: $[^{(1)}/^{(2)}]$	Gini post-tax	Gini pre-tax	Top-10% income-share	Top-5% income-share	Top-1% income-share
$\log(POP_{lt})$*$INEQUALITY_{lt}$	$3.66^{***/**}$	$4.14^{***/***}$	$1.97^{***/}$	$3.06^{***/}$	$3.88^{***/}$
$\log(GDP_{lt})$*$INEQUALITY_{lt}$	$-4.79^{***/***}$	$-7.11^{***/***}$	$-4.50^{***/}$	$-5.72^{***/}$	$-6.76^{***/}$
$INEQUALITY_{lt}$	$15.29^{***/**}$	$30.55^{***/***}$	$28.00^{***/**}$	$33.54^{***/**}$	$36.25^{***/**}$
$\log(POP_{lt})$	$-4.70^{***/***}$	$-5.20^{***/***}$	$-3.99^{***/***}$	$-3.95^{***/***}$	$-3.70^{***/***}$
$\log(GDP_{lt})$	$3.59^{***/***}$	$4.85^{***/***}$	$3.01^{***/***}$	$2.72^{***/***}$	$2.18^{***/***}$

Note: Estimation sample covers 385,929 observations. The dependent variable is aggregate patent-flows in sector i from country k to country l in year t. Sectors are measured by SITC Rev.2 1-digit codes. Estimation results derived from Quasipoisson regression with unconditional fixed-effects for sectors, origins, destinations, and years.
$[^{(1)}/^{(2)}]$ inference based on (1) clustering on sector and on (2) four-way-clustering on sectors, origins, destinations, and years. ***, **, and * indicate significance at 0.01, 0.05, and 0.1, respectively.

Results: Disaggregate Data (SITC 1 digit)

Inequality measure: $[^{(1)}/^{(2)}]$	Gini post-tax	Gini pre-tax	Top-10% income-share	Top-5% income-share	Top-1% income-share
$\log(POP_{lt})$*$INEQUALITY_{lt}$	$5.46^{***/***}$	$7.05^{***/***}$	$6.91^{***/***}$	$8.96^{***/***}$	$11.76^{***/***}$
$\log(GDP_{lt})$*$INEQUALITY_{lt}$	$-5.54^{***/***}$	$-9.42^{***/***}$	$-8.60^{***/***}$	$-10.54^{***/***}$	$-12.96^{***/***}$
$INEQUALITY_{lt}$	$16.47^{***/***}$	$36.78^{***/***}$	$39.54^{***/***}$	$47.02^{***/***}$	$52.68^{***/***}$
$\log(POP_{lt})$	$-6.86^{***/***}$	$-8.11^{***/***}$	$-7.51^{***/***}$	$-7.15^{***/***}$	$-6.32^{***/***}$
$\log(GDP_{lt})$	$5.39^{***/***}$	$7.67^{***/***}$	$6.16^{***/***}$	$5.57^{***/***}$	$4.50^{***/***}$
$RELSIZ_{klt}$	$8.14^{***/***}$	$9.36^{***/***}$	$9.66^{***/***}$	$9.57^{***/***}$	$9.14^{***/***}$
$RELTRADEOPEN_{klt}$	$-0.53^{***/}$	$-0.41^{***/}$	$-0.41^{***/}$	$-0.44^{***/}$	$-0.45^{***/}$
$COMLANG_{kl}$	0.01	0.01	0.01	0.01	$0.01^{/}$
$\log(DIST_{kl})$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$
$GP\text{-}INDEX_{lt}$	$0.25^{***/**}$	$0.23^{***/**}$	$0.18^{***/*}$	$0.20^{***/*}$	$0.21^{***/*}$

Note: Estimation sample covers 385,929 observations. The dependent variable is aggregate patent-flows in sector i from country k to country l in year t. Sectors are measured by SITC Rev.2 1-digit codes. Estimation results derived from Quasipoisson regression with unconditional fixed-effects for sectors, origins, destinations, and years.
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Results: Disaggregate Data (SITC 2 digit)

Inequality measure: $[^{(1)}/^{(2)}]$	Gini post-tax	Gini pre-tax	Top-10% income-share	Top-5% income-share	Top-1% income-share
$\log(POP_{lt})$*$INEQUALITY_{lt}$	$3.20^{***/*}$	$3.46^{***/***}$	$1.90^{***/}$	$2.92^{***/}$	$3.72^{***/}$
$\log(GDP_{lt})$*$INEQUALITY_{lt}$	$-4.20^{***/**}$	$-6.09^{***/***}$	$-4.03^{***/}$	$-5.16^{***/}$	$-6.13^{***/}$
$INEQUALITY_{lt}$	$13.53^{***/**}$	$26.44^{***/***}$	$24.83^{***/**}$	$30.06^{***/**}$	$32.77^{***/*}$
$\log(POP_{lt})$	$-4.36^{***/***}$	$-4.80^{***/***}$	$-3.78^{***/***}$	$-3.74^{***/***}$	$-3.50^{***/***}$
$\log(GDP_{lt})$	$3.27^{***/***}$	$4.32^{***/***}$	$2.76^{***/**}$	$2.50^{***/***}$	$2.02^{***/***}$

Note: Estimation sample covers 1,913,365 observations. The dependent variable is aggregate patent-flows in sector i from country k to country l in year t. Sectors are measured by SITC Rev.2 2-digit codes. Estimation results derived from Quasipoisson regression with unconditional fixed-effects for sectors, origins, destinations, and years.
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Inequality measure: $[^{(1)}/^{(2)}]$	Gini post-tax	Gini pre-tax	Top-10% income-share	Top-5% income-share	Top-1% income-share
$\log(POP_{lt})$*$INEQUALITY_{lt}$	$5.07^{***/***}$	$6.47^{***/***}$	$6.90^{***/***}$	$8.90^{***/***}$	$11.68^{***/***}$
$\log(GDP_{lt})$*$INEQUALITY_{lt}$	$-5.01^{***/***}$	$-8.52^{***/***}$	$-8.19^{***/***}$	$-10.07^{***/***}$	$-12.43^{***/***}$
$INEQUALITY_{lt}$	$14.84^{***/**}$	$33.14^{***/***}$	$36.52^{***/***}$	$43.79^{***/***}$	$49.57^{***/***}$
$\log(POP_{lt})$	$-6.50^{***/***}$	$-7.68^{***/***}$	$-7.28^{***/***}$	$-6.92^{***/***}$	$-6.08^{***/***}$
$\log(GDP_{lt})$	$5.09^{***/***}$	$7.16^{***/***}$	$5.91^{***/***}$	$5.35^{***/***}$	$4.33^{***/***}$
$RELSIZ_{klt}$	$8.09^{***/***}$	$9.14^{***/***}$	$9.52^{***/***}$	$9.44^{***/***}$	$9.01^{***/***}$
$RELTRADEOPEN_{klt}$	$-0.49^{***/}$	$-0.39^{***/}$	$-0.38^{***/}$	$-0.40^{***/}$	$-0.41^{***/}$
$COMLANG_{kl}$	0.01	0.01	0.01	0.01	0.01
$\log(DIST_{kl})$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$	$-0.19^{***/***}$
$GP\text{-}INDEX_{lt}$	$0.23^{***/**}$	$0.22^{***/}$	$0.18^{***/}$	$0.19^{***/}$	$0.20^{***/}$

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Results: Disaggregate Data (SITC 3 digit)

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Robustness of Results

- Using one-dimensional FE estimators for the Poisson model (independence over time!) with a FE for country pairs for the aggregate analysis, and a FE for each combination of origin-destination-sector yields qualitatively and quantitatively highly similar results.
- Results robust when using linear regression of log(depvar) or other glm estimators
- Robust to including further bilateral characteristics, measures of FDI, gross national savings, ...

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Conclusions

- Model and empirical results indicate that inequality is more likely beneficial for innovation the larger the population, and the less substitutable the marginal innovation is (more likely for low GDP)
- A positive effect of an increase in inequality on patent-inflows is more likely if a country has low GDPpc, but high-GDPpc destinations have more patent-inflows in total
- **Implications:** (1) Secular stagnation (running out of valuable innovations) makes it more likely that inequality is bad for innovation, (2) population growth has the opposite effect, and (3) by increasing demand for new innovative goods, a more equal distribution of income might c.p. lead to more innovation

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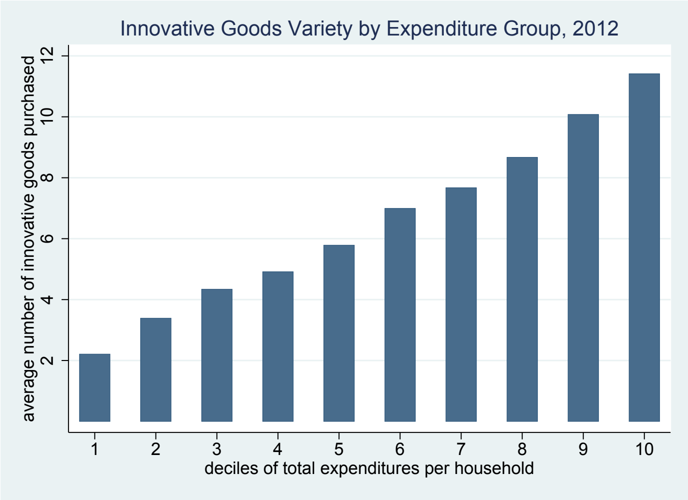
Differences in consumption pattern



Data from US consumer expenditure survey (CEX, INTR). 61 out of over 600 goods were classified as "innovative" (e.g. computers, digital audio players, new cars...). The number of "innovative" goods is defined as the number of these selected goods of which a household has purchased at least one unit in 2012 back

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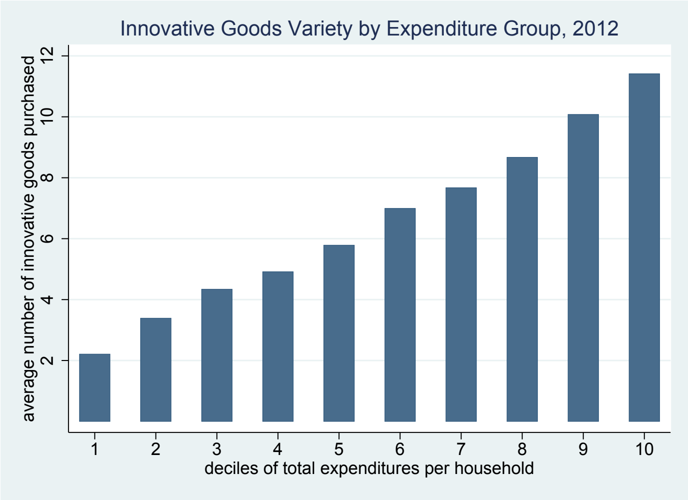

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Solving the Model

- **Profits** of firm selling at price $p(\theta)$ to all households with $\theta_i > \theta$:

$$\pi(\theta) = (p(\theta) - c)\, L(1 - G(\theta))$$

- **Free entry** ($\pi(\theta) = F$) implies: $p(\theta) = c + \frac{F}{L(1-G(\theta))}$
- For the threshold $\hat{\theta}$, above which households start purchasing non-innovative goods, $p(\hat{\theta}) = z(\hat{\theta}) = \Omega \frac{\partial f(C(\hat{\theta}))}{\partial C(\hat{\theta})}$ and $C(\hat{\theta}) = N$ must hold. This gives the free entry condition:

$$(\Omega \frac{\partial f(N)}{\partial N} - c)L(1 - G(\hat{\theta})) = F \qquad (1)$$

- From the budget constraint of household $\hat{\theta}$ ($y(\hat{\theta}) = \hat{\theta}\frac{Y}{L} = \int_{j=0}^{N} p_j dj$), we can derive:

$$N = C(\hat{\theta}) = \frac{Y}{L}\int_{s=0}^{\hat{\theta}} \frac{1}{p(s)} ds = \frac{Y}{L}\int_{s=0}^{\hat{\theta}} \frac{L(1 - G(s))}{cL(1 - G(s)) + F} ds \qquad (2)$$

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