Comparative Advantage and Risk Premia in Labor Markets

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Intro

- This paper is about the effect of comparative advantage and risk in the career choice of individuals and their role in explaining earnings differentials across industries.
- The compensation for risk in the labor market is a classical (old) problem first explored in Friedman and Kuznets (1939).
- The problem is more challenging: heterogeneity in abilities and endogenous career choice.
- We tackle this old and complex problem by using modern tools.

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  Need model to decompose mean earnings differentials into compensation for ability and risk.

What we do

- New Facts:
  - Quantify labor income risk across 21 sectors of the US economy (permanent and transitory).
  - Estimate a relationship between risk (or its two components) and earnings (the "risk premium").
- Theory:
  - Model with sectoral, consumption/savings choices:
    - Sectoral differences in earnings risk.
    - Workers differ in their ability levels (sector-specific).

Why we care

- For most individuals labor income is the bulk of the total income.
- Labor income risk plays a central role in many economic decisions that individuals make (consumption/savings, portfolio choice, etc.).
- Implications for income and wealth inequality.
- Understand the role of comparative advantage and risk in wage inequality. Implications for policy.

Preview of Main Results

- Find strong and positive relationship between the variance of labor income shocks (both transitory and permanent) and mean earnings.
  - Moving from the safest to the riskiest industry is associated with an increase of 10% in mean earnings.

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- The correlation between mean earnings and the variance of the permanent shock is compensation for risk (with risk aversion parameter of 2).

- The correlation between mean earnings and the variance of the transitory shock is compensation for sector specific skills (comparative advantage).

Outline of the Talk

- Part I - The Story in a Static "Toy" General Equilibrium Model.
- Part II - Data and Estimation.
- Part III - Full General Equilibrium Model.
- Part IV - Findings.

Part I

“TOY” GE MODEL

Risk vs. Ability

Environment

- Risk averse individuals that live for 1 period.
- Firm produce output according to $Y = (L^1)^\phi (L^2)^{1-\phi}$.
- Competitive labor market in which individuals choose type-1 or type-2 labor:
  - w^1
  - $w^2 z\gamma$ with
    - $z \sim G(z)$
    - $\gamma = 1$ with prob. p and $\gamma = \gamma_H > 1$ with prob. $1 - p$.
- Individuals know z but not the realization of γ.
- Individuals choose the labor type that renders the highest utility.

Decision Problem

- Assume log utility, then there exist a unique $z^\star$ s.t. if $z > z^\star$ individuals choose type-2 labor and if $z \leq z^\star$ type-1.

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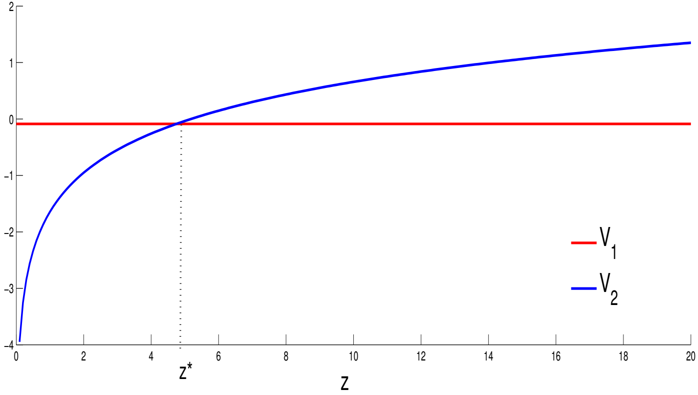

Equilibrium

- Firm max profits

$$w^1 = MPL_1,$$

$$w^2 = MPL_2.$$

- Aggregating

$$L_1 = G(z^\star)$$

$$L_2 = E_\gamma \int_{z^\star}^{\infty} z dG(z).$$

- Mean Earnings

$$e_2 = \frac{w^2 \int_{z^\star}^{\infty} z dG(z)}{1 - G(z^\star)}.$$

$$e_1 = w^1$$

The Price of Risk

- Changes in the variance of earnings for labor-type 2.

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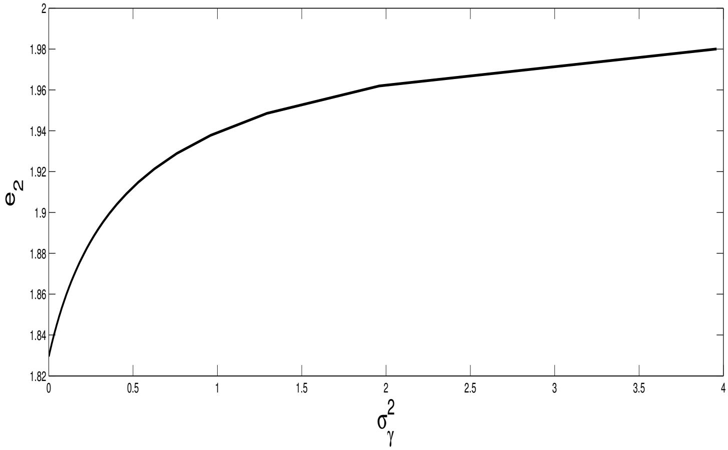

Risk vs Ability: Example

- We *increase* the mean ability levels, $E(z)$ (affects earnings of type-2 labor). Curves shift upwards.

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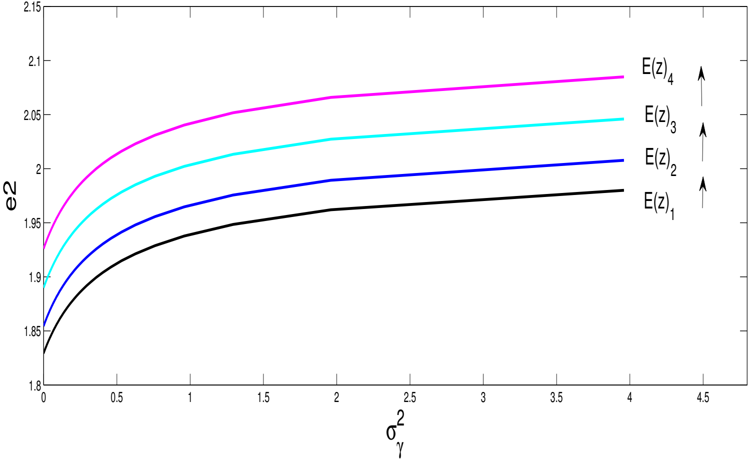
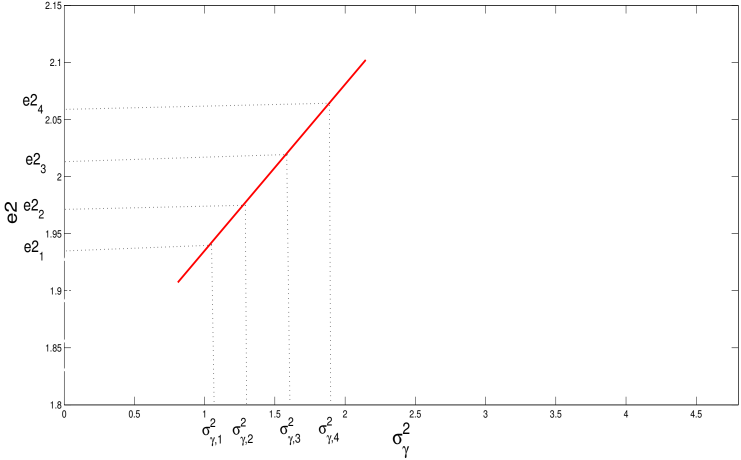


Risk vs Ability: Example

- Suppose there is a set of islands (sectors or industries).
- Each island is characterized by a different pair of volatility of earnings (σ_γ^2) and mean ability level ($E(z)$).
- What would we be the observed relationship between volatility and earnings?
- What would we be the observed relationship between volatility and mean ability?

Risk vs Ability: Case 1 (as in the data)



- **Earnings and Risk are *positively* correlated.**

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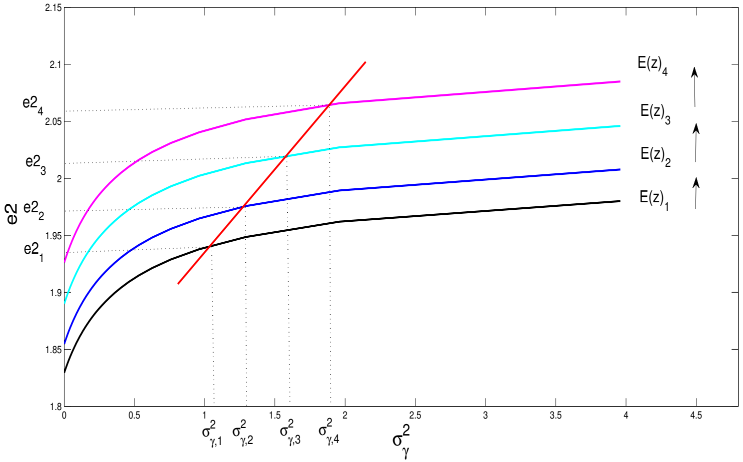

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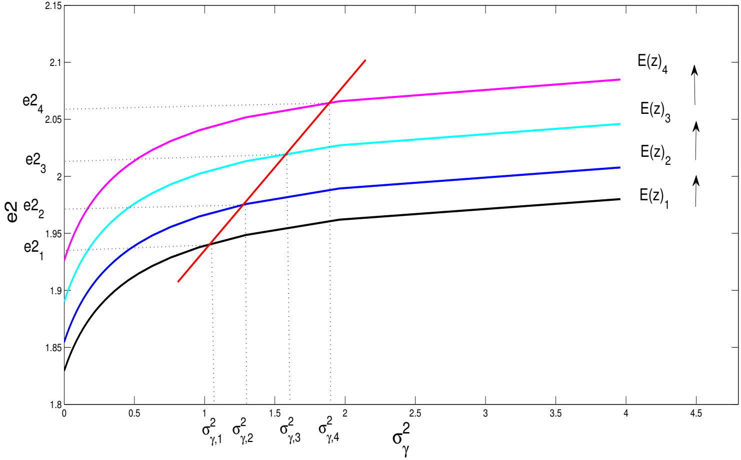

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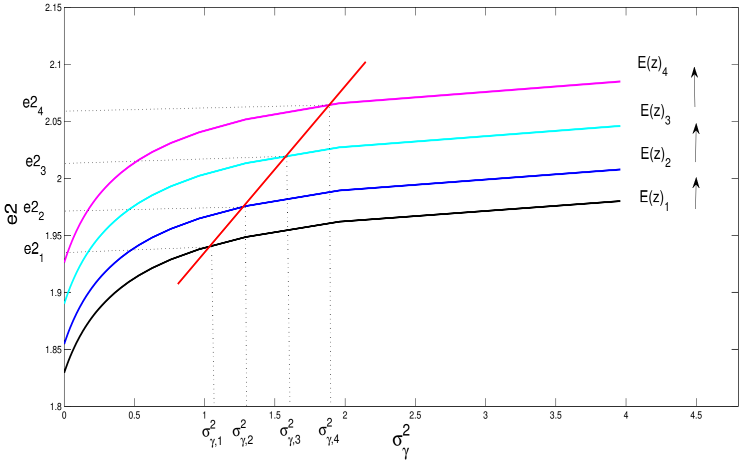
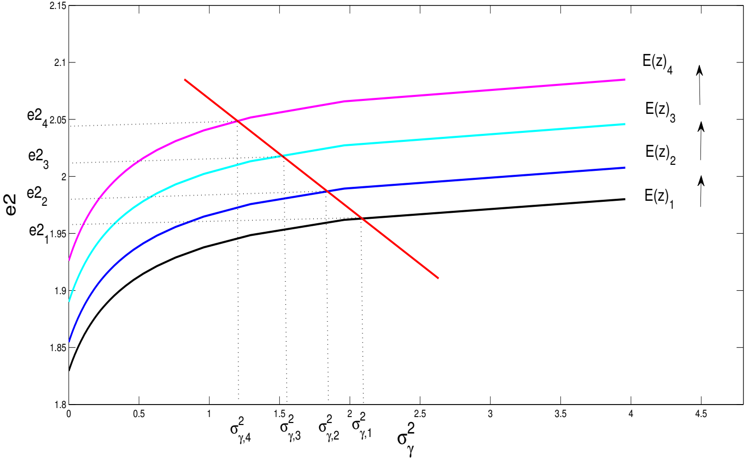


- **Earnings and Risk are *positively* correlated. Risk (σ^2_γ) and Ability ($E(z)$) are *positively* correlated.**

Risk vs Ability in GE: Case 2



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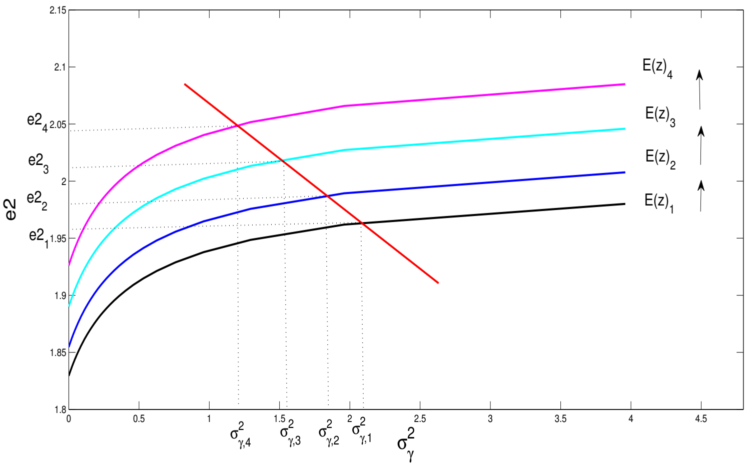

- **Earnings (e_2) and Risk (σ^2_γ) are *negatively* correlated.**

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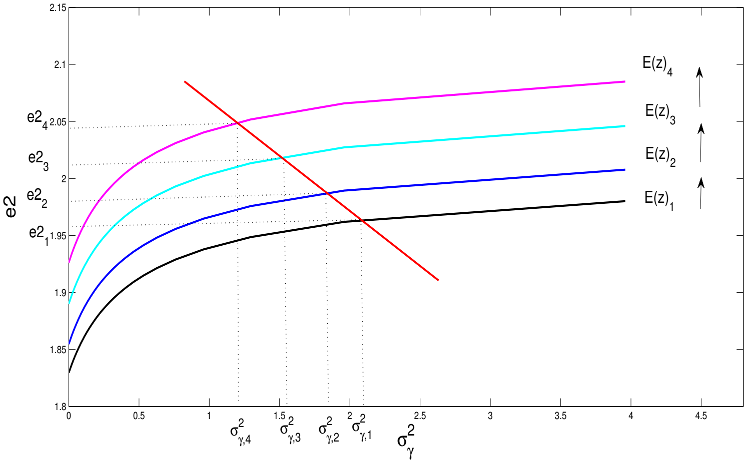

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Part II

DATA

Earnings and Risk in Labor Markets

Data

- Survey of Income and Program Participation (SIPP).
- Use 3 surveys:
  - 1996-1999.
  - 2001-2003.
  - 2004-2007.
- Construct a panel of individuals (of length T) for each of the three.
- Obtain quarterly measures of labor earnings, unemployment insurance, employment status, age, education level, industry, occupation, gender. clean

Estimating Risk

- Estimate (for each panel):

$$log(Y_{ijt}) = y_{ijt} = \alpha_{ij} + \boldsymbol{\beta}_j \boldsymbol{X}_{ijt} + u_{ijt}.$$

  - Predictable component.
  - Unpredictable component: our notion of risk.

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  - Unpredictable component: our notion of risk.

- Not all risks are created equal.

  - Transitory shocks to income are easy to smooth with a buffer stock of savings.
  - Permanent (or very persistent) shocks are more serious.

Decomposing Risk: Estimation

- Assume: (Carroll and Samwick (1997); Low, Meghir and Pistaferri (2010))

$$u_{ijt} = \eta_{ijt} + \omega_{ijt} \qquad \eta_{ijt} \sim N(0, \sigma^2_{j,\eta})$$

$$\omega_{ijt} = \omega_{ij,t-1} + \epsilon_{ijt} \qquad \epsilon_{ijt} \sim N(0, \sigma^2_{j,\epsilon}).$$

- Estimation:

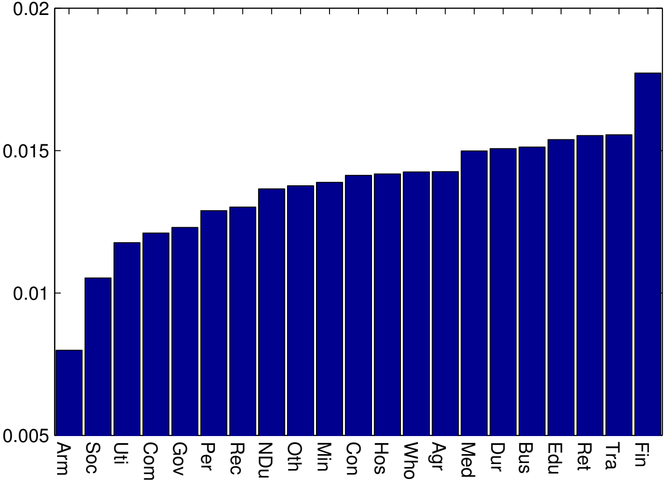
$$\Delta y_{ijt} = \Delta \boldsymbol{\beta}_j \boldsymbol{X}_{ijt} + \Delta \eta_{ijt} + \epsilon_{ijt}.$$

$$g_{ijt} = \Delta(y_{ijt} - \boldsymbol{\beta}_j \boldsymbol{X}_{ijt}) = \Delta \eta_{ijt} + \epsilon_{ijt}$$

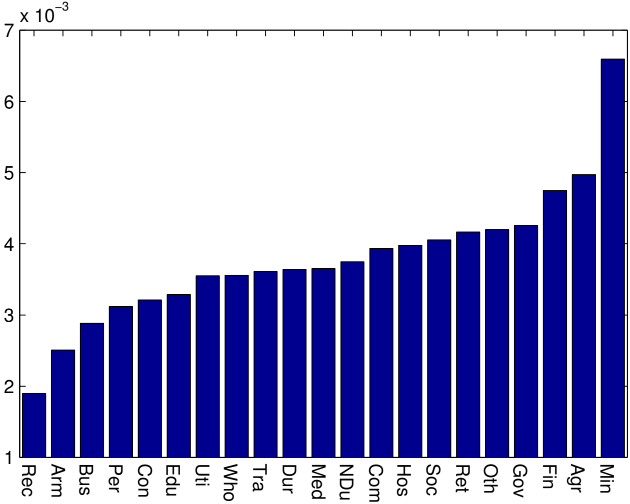
$$E(g^2_{ijt}) = \sigma^2_{\epsilon_{ij}} + 2\sigma^2_{\eta_{ij}}$$

$$E(g_{ijt} g_{ijt-1}) = -\sigma^2_{\eta_{ij}}.$$

Results: Permanent Shock



Results: Transitory Shock



Earnings and Risk

- Relate our 21 industry-specific risk measures to average industry earnings.

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- Use individual-specific information to obtain earnings *net of observables*. Estimate the following pooled regression:

$$y_{ijt} = \gamma_0 + \boldsymbol{\gamma} \boldsymbol{X}_{ijt} + \lambda_{ijt}$$

- Then compute

$$\tilde{y}_{ijt} = y_{ijt} - \hat{\boldsymbol{\gamma}} \boldsymbol{X}_{ijt} \quad \text{and} \quad \tilde{y}_j = \frac{1}{N_j} \frac{1}{T} \sum_{i=1}^{N_j} \sum_{t=1}^{T} \tilde{y}_{ijt}$$

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- Estimate

$$\tilde{y}_j = \alpha_0 + \alpha_1 \sigma^2_{\epsilon,j} + \alpha_2 \sigma^2_{\eta,j} + \nu_{\tilde{y},j}.$$

Result: The Premium

Table : Regression Results - Permanent and Transitory

Variable	Coefficient (Prob. < 0)
constant	6.37
	(0.000)
Permanent σ_{ϵ}^{2}	6.87
	(0.0152)
Transitory σ_{η}^{2}	16.59
	(0.0771)

- Permanent: Social Services to Finance (5%).
- Temporary: Recre. and Ent. to Mining (8%).

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MAIN QUESTION

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- However, sorting of individuals is endogenous!
  Their sectoral choice depends on: risk they face and their comparative advantage.
- The apparent risk premium can potentially be an artifact of our inability to control for self-selection into unobservables (Roy (1951)).
- Which part of the earnings differential is compensation for risk and which part is due to selection? Need Theory.

Part III

GENERAL EQUILIBRIUM MODEL

Earnings and Risk in Labor Markets

Environment

- Mass-one continuum of risk averse individuals.
- Live for S periods (death certain at $S + 1$).
- Born into the labor market of a small open economy and never retire.

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- Mass-one continuum of risk averse individuals.
- Live for S periods (death certain at $S+1$).
- Born into the labor market of a small open economy and never retire.
- Comparative advantage: at birth, each individual draws a value for sector-specific skill (fixed)

$$\Omega_{i,0} = \{\theta_{i,1}, \ldots, \theta_{i,J}\}$$

where the logarithm of each value $\theta_{i,j}$ is drawn from an industry-specific distribution $N(\mu_{\theta_j}, \sigma^2_{\theta_j})$.

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  - Transitory: η_j is an i.i.d. shock to log earnings, $N(-\frac{1}{2}\sigma^2_{j,\eta}, \sigma^2_{j,\eta})$.
  - Permanent: $\omega_{s+1,j} = \omega_{s,j} + \epsilon_{s,j}$ with ϵ_j being $N(-\frac{1}{2}\sigma^2_{j,\epsilon}, \sigma^2_{j,\epsilon})$ i.i.d.

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- Allow individuals to save in a one period risk-free bond, b.

Production

- Consumption good in industry j (identical across industries, no trade) produced according to

$$Y_j = N_j^{\alpha_j}.$$

- Produced by competitive firms owned by foreigners (pay wages and collect profits).

Optimization

- Let $x = (b, \omega, \eta, s, \theta_j)$ the individual state.
- At $i = 0$ optimal sector choice solves:

$$j^* = argmax \{W_1, \ldots, W_J\}$$

where W_{j^*} for an individual i is defined as

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- $$V_j(x) = \max_{c,b'} \{u(c) + \beta E V_j(x')\}$$

with $u_c > 0$ and $u_{cc} < 0$

subject to,

$$c + b' = w_j \theta_j e^{\eta} e^{\omega} + b(1 + r)$$

$$b \geq \underline{b}, \ \ b_0 = 0, \ \ b_{S+1} \geq 0.$$

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Part IV

FINDINGS

Quantitative Analysis

Calibration

- Restrict the analysis to 4 industries ($J = 4$), Agriculture, Manufacturing, Services and Public Sector.
- Feed the model with the estimated variances of permanent and transitory shocks, i.e. $\sigma^2_{\epsilon,j}$ and $\sigma^2_{\eta,j}$ for j=1,2,3,4.
- Abilities: pick $\{\mu_{\theta_j}, \sigma^2_{\theta_j}\}$ for $j = 1, 2, 3, 4$ so that we exactly match *mean* and *standard deviation* of *earnings* in each of the 4 industries.

Rest of Parameters

- Labor shares: 0.30 (Agriculture), 0.63 (Manufacturing), 0.51 (Services) and 0.85 (Public Sector). Taken from NIPA.
- $S = 120$.
- $\beta = 0.957$ to match aggregate wealth income ratio of 3.
- Set $r = 0.05$ (annual).
- Assume $u(c) = \frac{c^{1-\xi}}{1-\xi}$ and set $\xi = 2$. RiskPref

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Result 1
Earnings Across Sectors

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Transitory σ_η^2	8.38

Result 2
Savings and Career Choice

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Table : Wealth to Income Ratios

	Mean
Total Economy	3.04
Agriculture	3.25
Manufacturing	3.53
Services	3.17
Public Sector	1.03
Correl. Permanent Risk	0.99

Result 3
Decomposition of Earnings

- Counterfactual Experiment: Shut down all the differences across individuals and across sectors in the pre-labor market skills, i.e. let individuals to be ex-ante homogenous.

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	Benchmark	Counterfactual
Variable	Coefficient	Coefficient
constant	6.39	6.32
Permanent σ_{ϵ}^2	8.51	15.1
Transitory σ_{η}^2	8.38	0.9

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Result 4
Implications for Inequality

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Implications for Inequality

Table : Model Predictions

	Gini Index
Benchmark	0.45
No Ability Diff.	0.38
No Variance Diff.	0.44
No Tech. Diff.	0.46

Final Remarks

- The first paper that integrates Roy's ideas into the analysis of career choice under uninsurable idiosyncratic labor earnings risk in a general equilibrium framework.

- Measured risk depends on individuals abilities and their career choice.

- Inequality is partly the outcome of career choices.

- Central for the analysis of policies aimed to modify initial conditions and those to provide insurance to shocks.

Future Avenues
Open the box

- Income taxation.
- Career choice with financially constrained individuals.
- Go one step before: how to get to the observed abilities and career choice (human capital acc.).
- Female's career choices (comparative advantage and flexibility).
- CEO's compensation.
- Equity investment of different sectors to hedge sectoral labor income risk.
- Marriage market to hedge labor income risk.

Sectors vs Occupations

Table : Distribution of Sectors

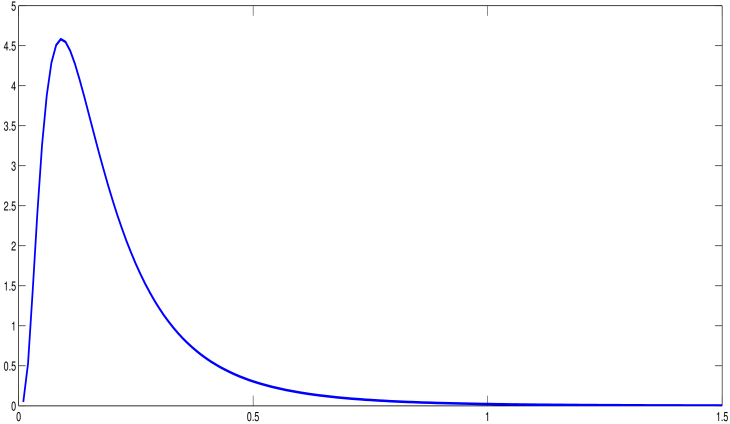
Occupation	# Sectors Conc. 50%	Names
1 Executive, Administrative and Managerial	5	20, 4, 11, 17
5 Administrative Support including Clerical	4	20, 11, 6, 17
3 Technicians and Related Support	4	15, 4, 16, 5
8 Services except household and protective	3	16, 10, 15
10 Precision Production, Craft and Repair	3	4, 3, 5
13 Handlers, Equipment Cleaners, Helpers and Laborers	3	10, 4, 5
12 Transportation and Material Moving	2	6, 9
2 Professional Specialties	2	17, 15
4 Sales	2	9, 10
7 Protective Services	1	20
9 Farming, Forestry and Fishing	1	1
11 Machine Operators, Assemblers and Inspectors	1	4
14 Soldiers	1	21

Back

Risk Preferences

- Add heterogeneity in risk preferences.
- Use estimates in Kimball et. al. (JASA, 2008).
- Use survey questions on lifetime income gambles from the Health and Retirement Study.
- CRRA utility function and log-normal distribution.
- Risk aversion: Mean (8.2), St. Dev. (6.8), Median (6.3), Mode (3.7). RiskFig Back

Risk Tolerance Distribution



Industry Switchers

- Types of switches:
  - Career progression: beyond the scope of this paper.
  - Because of a negative shock: give a worker the opportunity to smooth out shocks by changing industries.
  - Option value: A worker may choose a risky industry even though it offers a low wage!

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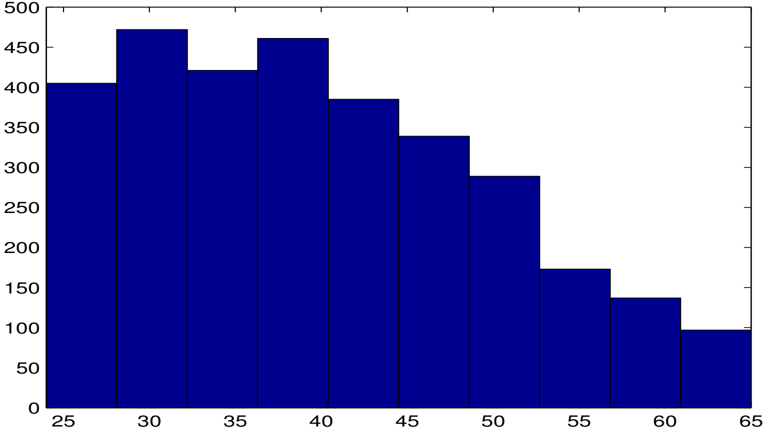
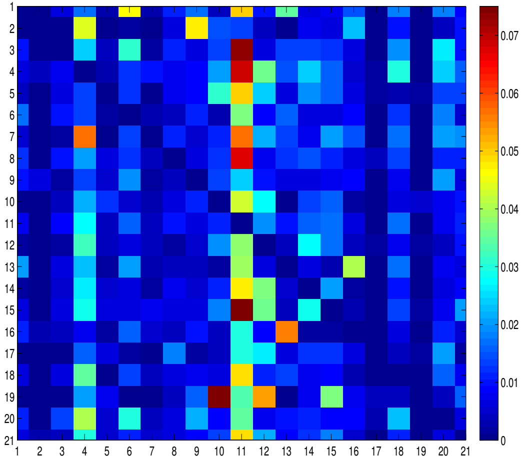
- What the data tell?
  - In our sample the percentage of switchers is 5.2%
  - Age profile of switchers. SwitchAge
  - Option value? Transmat

Switches by Age



Transition Matrix



Back

Risk and Labor Choice

- The mechanics behind the increase in mean earnings. $\sigma^2_{\gamma,3} > \sigma^2_{\gamma,2} > \sigma^2_{\gamma,1}$ then $z^\star_3 > z^\star_2 > z^\star_1$. Back

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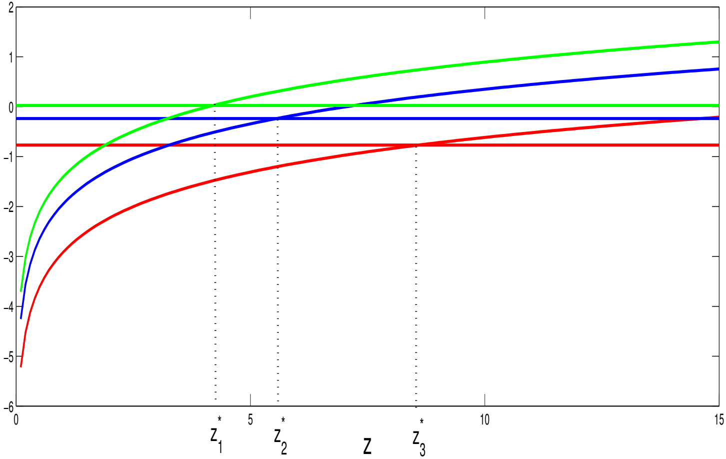

Estimating Risk: Monte Carlo Experiment

Table : True values: $\sigma_\eta^2 = 0.01$, $\sigma_\epsilon^2 = 0.005$

	$T = 8$	$T = 16$	$T = 64$
$N = 10$	0.01197, 0.0032	0.0095, 0.00524	0.01025, 0.00505
	(3.48×10^{-3})	(1.59×10^{-3})	(1.43×10^{-3})
	(2.50×10^{-3})	(1.65×10^{-3})	(7.13×10^{-4})
$N = 100$	0.00984, 0.00502	0.01032, 0.00483	0.00999, 0.00503
	(1.46×10^{-3})	(7.39×10^{-4})	(4.57×10^{-4})
	(6.90×10^{-4})	(5.4×10^{-4})	(2.72×10^{-4})
$N = 1000$	0.00991, 0.00507	0.09998, 0.00498	0.01001, 0.00500
	(3.66×10^{-4})	(1.42×10^{-4})	(1.42×10^{-4})
	(3.25×10^{-4})	(9×10^{-4})	(7.07×10^{-5})

Cleaning the Data

- We focus on the primary job of the individual (SIPP reports secondary jobs) and eliminate those who:
  - Simultaneously report missing earnings but positive hours worked.
  - Report working in two different industries or those who do not report their industry (self-employed).
  - Report being out of the labor force.
  - Do not report complete samples.
- Restrict analysis to married individuals older than 22 but younger than 66.
- We redefine earnings to be unemployment insurance if an individual reports zero hours worked and reports being unemployed. For those individuals who are employed we also eliminated those with very low earnings (less than 600 1996 dollars per month). Back

Equilibrium - Part I

Industry wages $\{w_j\}_{j=1}^J$, industry populations (or masses) $\{\mu_j\}_{j=1}^J$, industry-specific distributions $\{\Psi_j(x)\}_{j=1}^J$, industry-level efficiency-weighted employment levels $\{N_j\}_{j=1}^J$, and industry-specific decision rules $\left\{b_j'(x), c_j(x)\right\}_{j=1}^J$ and associated value functions $\{V_j(x)\}_{j=1}^J$, such that:

- **1.** Given wages, $\left\{b_j'(x), c_j(x)\right\}_{j=1}^J$ solve the optimization problem yielding value functions $\{V_j(x)\}_{j=1}^J$.
- **2.** Industry-specific populations $\{\mu_j\}_{j=1}^J$ and the distributions of abilities across industries are consistent with the optimal industry choice.

Equilibrium - Part II

- **3.** Wages in industry j are equal to the marginal product of a marginal unit of average efficiency in that industry:$w_j = \alpha_j N_j^{\alpha_j - 1}$, where the industry-level measures of employment are defined as $N_j = \mu_j \int_{\mathcal{S}} \theta_j e^{\eta} e^{\omega} d\Psi_j(x)$.

- **4.** In a given j, $\Psi_j(x)$ is the stationary distribution associated with the transition function implied by the optimal decision rule $b_j'(x)$ and the law of motion for the exogenous shocks.

- **5.** At the industry level, the following resource constraint is satisfied: $w_j N_j = \int_{\mathcal{S}} \{c_j(x) + b_j'(x) - b_j(x)(1+r)\} d\Psi_j(x)$

Model Computation - Part I

- **1.** Discretize the distributions for the selection parameters. Construct an equi-spaced grid of length $N_R = 10$ for the support of each distribution $G_R^j = \left\{\hat{\theta}_j^1, \ldots, \hat{\theta}_j^{N_R}\right\}$

- **2.** Guess masses $\{\mu_j\}_{j=1}^J$ and efficiency levels $\left\{\theta_j^*\right\}_{j=1}^J$ for each of the industries. This yields aggregate employment levels (in efficiency units) $\{N_j\}_{j=1}^J$ and wage rates for each of the four industries.

- **3.** Given a set of wages we compute the individual's life-cycle problem for each industry and for each value of the industry-specific ability. To solve for the value and policy functions we discretize the space of bond holdings $(N_B = 100)$ and use linear interpolation to approximate future value functions. We discretize the values of the persistent and temporary shocks, ω and η. We use $N_P = 5$ and $N_T = 2$.

- **4.** The previous step yields a set of N_R expected value functions for each industry j conditional on a given level of ability,

$$\left\{\left\{\mathbb{V}_j^k = \int V_j(x|\theta_j = \hat{\theta}_j^k) d\Psi_j(x)\right\}_{k=1}^{N_R}\right\}_{j=1}^J.$$

Back

Model Computation - Part II

- **5.** Completing the previous step yields, four each industry, a set of three vectors: a grid $G_{\tilde{R}^j} = \left\{\tilde{\theta}_j^1, \ldots, \tilde{\theta}_j^{N_{\tilde{R}}}\right\}$, a vector of associated probabilities for each element in $G_{\tilde{R}^j}$, $\left\{\tilde{p}_j^1, \ldots, \tilde{p}_j^{N_{\tilde{R}}}\right\}$, and a vector of associated value functions $\left\{\left\{\tilde{\mathbb{V}}_j^k\right\}_{k=1}^{N_{\tilde{R}}}\right\}_{j=1}^{J}$.
- **6.** Denote by $K^* = (N_{\tilde{R}})^J$ the set of all possible combinations of the J ability parameters. In other words there are K^* possible values for the vector $\left\{\tilde{\theta}_1^{i_1}, \ldots, \tilde{\theta}_J^{i_J}\right\}_{i_1,\ldots,i_J=1}^{N_{\tilde{R}}}$. The number $p_{T(i_1,\ldots,i_J)} = p_1^{i_1} \times \ldots \times p_J^{i_J}$ is the probability attached to the event an individual draws the vector $\theta_1^{i_1}, \ldots, \theta_J^{i_J}$. There are K^* such probabilities and $\sum_{k=1}^{K^*} p_k = 1$. For each J-tuple $\{i_1, \ldots, i_J\}$ there is also a set of value functions $\left\{\tilde{\mathbb{V}}_1^{i_1}, \ldots, \tilde{\mathbb{V}}_J^{i_J}\right\}$, and an associated index $j^* = argmax\left\{\tilde{\mathbb{V}}_1^{i_1}, \ldots, \tilde{\mathbb{V}}_J^{i_J}\right\}$ that represents the optimal industry choice for that particular vector of industry-specific skills.
- **7.** Once we have computed the optimal industry j^* for each combination of skill-specific vectors, we are ready to update the guesses for the industry populations and the average efficiencies in each industry.

Two Additional Experiments

- Shut down all the differences in the variance of shocks across sectors. ▸ exp2
  - Correlation of mean earnings with variance of *permanent* shock is *negative*.
  - Correlation of mean earnings with variance of *transitory* shock is *positive*.

Two Additional Experiments

- Shut down all the differences in the variance of shocks across sectors. exp2
  - Correlation of mean earnings with variance of *permanent* shock is *negative*.
  - Correlation of mean earnings with variance of *transitory* shock is *positive*.

- Shut down industries' technological differences, i.e. the same α across sectors. exp3
  - Correlation of mean earnings with variance of *permanent* shock is *positive*.
  - Correlation of mean earnings with variance of *transitory* shock is *positive*.

Back

Experiment 2

- Shut down all the differences in the variance of shocks across sectors. ◂ Back

Experiment 2

- Shut down all the differences in the variance of shocks across sectors. ◂ Back

Table : Regression Results - Permanent and Transitory

	Benchmark	Counterfactual
Variable	Coefficient	Coefficient
constant	6.39	6.83
Permanent σ_{ϵ}^2	8.51	-24.8
Transitory σ_{η}^2	8.38	9.2

Experiment 3

- Shut down industry's technological differences, i.e. the same α across sectors. Back

Experiment 3

- Shut down industry's technological differences, i.e. the same α across sectors. Back

Table : Regression Results - Permanent and Transitory

	Benchmark	Counterfactual
Variable	Coefficient	Coefficient
constant	6.39	6.41
Permanent σ_ϵ^2	8.51	21.3
Transitory σ_η^2	8.38	42.1

Key Empirical Objects

- Restrict the analysis to 4 industries ($J = 4$)
  Agriculture, Manufacturing, Services and Public Sector.

Table : Earnings and Variance of Earnings - 4 Industries

	Mean Earnings	Std. Dev.	σ_ϵ^2	σ_η^2
Agriculture	6.55	0.3687	0.0141	0.0058
Manufacturing	6.54	0.3869	0.0143	0.0035
Services	6.53	0.3287	0.0141	0.0036
Public Sector	6.50	0.4095	0.0101	0.0034
Correl. w/Earnings			0.88	0.69

Back

Earnings Per Hour

	Earnings	Net Earnings
$constant$	-8.12	1.3928
	(0.0055)	(0.0000)
$female$	-0.34	
	(0.0041)	
age	0.49	
	(0.0012)	
age^2	-0.01	
	(0.0020)	
$education$	0.15	
	(0.0008)	
σ_ϵ^2	6.42	3.09
	(0.0509)	(0.0425)
σ_η^2	17.30	0.26
	(0.1338)	(0.5387)

The Sorting of Workers

The Sorting of Workers

Table : Share of Workers by Industry

	Model	Data
Agriculture	0.03	0.02
Manufacturing	0.05	0.24
Services	0.73	0.65
Public Sector	0.18	0.10
Correlation with Data		0.92