Earnings Dynamics, Mobility Costs and Transmission of Firm and Market Level Shocks

Preliminary and Incomplete

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Introduction: Motivation

- The canonical model of a competitive labor market predicts that firm-level productivity shocks do not transmit to workers' wages
  - This prediction is at odds with evidence from several countries (e.g. Guiso et al., 2004; Friedrich et al., 2014; Card et al., 2015)

- In the presence of mobility costs:
  - Workers not only face the risk of shocks to their productivity
  - Workers' wages may depend on productivity shocks at
    - the firm level
    - the market (i.e., region and industry) level

Introduction: What we do

- The goal of this paper is to use US data to:
  1. Quantify the extent to which firm and market level productivity shocks are transmitted to wages
  2. Recover the frictions or costs to worker mobility across firms and markets from the transmission of productivity shocks
  3. Examine how taxes and transfers as well as the family affect shock transmission and reallocation costs

- To achieve these goals, we:
  - Develop a tractable model, linking workers' wages to firm and market shocks
  - Combine US population tax records with corporate income tax returns from years 2001-2014, giving panel data on:
    - workers' wages and their firm, region and industry
    - individual and family income, pre and post tax and transfers
    - measures of firm productivity and output

Introduction: Outline

1. Apply standard empirical specifications to perform:
   a) Worker-firm, permanent-transitory earnings decompositions
   b) Estimation of pass through of firm shocks to workers' earnings
2. Use a tractable model of the labor market which:
   - Provides economic assumptions rationalizing analysis in 1)
   - Presents a model based interpretation of the pass through rate
   - Offers a link between the pass through and firm effects in AKM
3. Extend the model to derive empirical specifications consistent with important features of the data, including:
   - Existence of market level shocks
   - Heterogeneity in pass through across workers, areas and industries
   - Discrepancy in size of firm and market components in a) and b)
   - Difference in the pass through of permanent and transitory shocks
4. Estimate how taxes and transfers as well as the family shock transmission and reallocation costs

Introduction: Our study and related literatures

- Our study provides some of the first U.S. evidence on earnings dynamics and transmission of productivity shocks
  - In labor market with workers and firms in different markets
- Our results are informative about:
  - Costs to worker mobility across firms and markets
  - Sources of inequality, and how they vary over time, between areas, and across the income distribution
  - The importance of various sources of insurance or attenuation
- Our study links estimates of pass through (e.g., Guiso et al., 2004; Friedrich et al., 2014) to firm effects (e.g., Abowd, Kramarz, and Margolis, 1999; Card, Cardoso, and Kline, 2016)

Data and sample selection

- We study administrative data from the U.S.
  - Population tax records for individuals and families
  - Corporate income tax return
    - Covering the years 2001-2014:
- In line with existing work, our baseline estimation sample:
  - Consists of prime-age men, aged 30-55
  - Excludes observations in firms with less than 10 workers
  - Exclude regions with fewer than 10 industries and industry-region pairs with fewer than 10 firms
  - Keeps observations with at least six consecutive years of:
    - Earnings $\succeq$ full-time employment minimum-wage equivalent
    - Staying at the same firm
- This gives us a sample of 2,407,261 (57,872) unique workers (firms) $\Longrightarrow$ Table – Sample Selection

Descriptive Statistics

Panel A.	**Sample Size**	
	Mean	**Median**
Individuals / Firm	1930	48
Firms / Industry x Region	35	20
Industry x Regions / Region	20	17

Panel B.	**Variance**	
	Log Wages	**Log Value-added**
Between Individual	0.4529	
Between Firm	0.1842	7.8470
Between Industry x Region	0.1017	5.1343
Between Region	0.0782	3.3444
	0.0252	1.6843

Estimating equations

- Consider the following process for value added y_{jt} and earnings of stayers w_{it}, assuming stochastic components are uncorrelated:

value added	earnings
$y_{jt} = y^p_{jt} + u_{jt}$	$w_{it} = w^p_{it} + v_{it}$
$y^p_{jt} = y^p_{jt-1} + \xi_{jt}$	$w^p_{it} = w^p_{it-1} + \mu_{it} + \underbrace{\gamma\xi_{j(i),t} + \delta_{j(i),t}}_{\text{common at the firm}}$

- Identify parameters from auto-covariance of growth:

$$\mathbb{E}[(\Delta w_{it})^2] + 2 \cdot \mathbb{E}[\Delta w_{it} \Delta w_{it-1}] = \gamma^2\sigma^2_\xi + \sigma^2_\delta + \sigma^2_\mu$$

$$\mathbb{E}[(\Delta \bar{w}_{jt})^2] + 2 \cdot \mathbb{E}[\Delta \bar{w}_{jt} \Delta \bar{w}_{jt-1}] = \underbrace{\gamma^2\sigma^2_\xi + \sigma^2_\delta}$$

$$\mathbb{E}[(\Delta y_{jt})^2] + 2 \cdot \mathbb{E}[\Delta y_{jt} \Delta y_{jt-1}] = \sigma^2_\xi$$

$$\mathbb{E}[\Delta y_{j(i)t} \Delta w_{it}] = \gamma\sigma^2_\xi$$

Estimated parameters of the earnings process

	Model 1: Worker	Model 2: Worker and Firm	Model 3: Worker, Firm and Market
Panel A.		**Permanent Variance**	
Individual (σ_μ^2)	0.0126	0.0090	
Firm ($\gamma^2\sigma_\xi^2 + \sigma_\delta^2$)		0.0037	
Industry x Region			
Region			
Panel B.		**Transitory Variance**	
Individual	0.0128	0.0114	
Firm		0.0014	
Industry x Region			
Region			
Panel C.		**Moving Average Coefficient**	
Individual	0.1493	0.1337	
Firm		0.2800	
Industry x Region			
Region			

Variance decomposition of the earnings process

	Model 1: Worker			Model 2: Worker and Firm			Model 3: Worker, Firm and Market		
	Values	**Shares**	**Cons. Eq.**	**Values**	**Shares**	**Cons. Eq.**	**Values**	**Shares**	**Cons. Eq.**
Panel A.				**Permanent Component**					
Individual	0.0126	36.2%	-19.7%						
Firm									
Industry x Region									
Region									
Panel B.				**Transitory Component**					
Individual	0.0223	63.8%							
Firm									
Industry x Region									
Region									
Panel C.				**Total**					
Individual	0.0349	100%							
Firm									
Industry x Region									
Region									

Estimated parameters of the value-added process

	Model 1: Worker and Firm	Model 2: Worker, Firm and Market
Panel A.	**Permanent Shock**	
Firm	0.0844	
Industry x Region		
Region		
Panel B.	**Transitory Shock**	
Firm	0.0614	
Industry x Region		
Region		
Panel C.	**Moving Average Coefficient**	
Firm	0.1493	
Industry x Region		
Region		

Pass-through

	Permanent Shock Std. Dev.	Pass-through Coefficient	Pass-through Effect Size
Panel A.		**Model 1**	
Firm	0.2905	0.0851	2.47%
Panel B.		**Model 2**	
Firm			
Industry x Region			
Region			

Pass-through estimation details

From statistics to economics....

- What *statistical* assumptions justify the estimating equations?

value added	earnings
$y_{jt} = y^p_{jt} + u_{jt}$	$w_{it} = w^p_{it} + v_{it}$
$y^p_{jt} = y^p_{jt-1} + \xi_{jt}$	$w^p_{it} = w^p_{it-1} + \mu_{it} + \gamma\xi_{j(i),t} + \delta_{j(i),t}$

where elements of (u_{jt}, ξ_{jt}) and $(\delta_{jt}, v_{it}, \mu_{it})$ are uncorrelated and $\mathbb{E}[v_{it}, \mu_{it} | \xi_{j(i),t}, \delta_{j(i),t}, u_{jt}] = 0$

- What *economic* model can rationalize these estimating equations?
- What's the interpretation of the estimates through the lens of this model?

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Environment

- We consider a simple labor market model based on random preferences as in Card, Cardoso, Heining, and Kline (2016):
  - large population of firms indexed by $j = 1..J$
  - large population of workers indexed by $i \in I$
  - time is discrete indexed by t

- **Individual** i has productivity x_{it} and **preferences**:

$$u_{ij}(W) = \beta \log W + g_j + \epsilon_{ij}$$

  - where ϵ_{ij} are iid type-1 extreme value
  - g_j are firm specific preferences common to all workers

- **Firm** j with work force $I_{jt} \subset I$ has access to the following production **technology**:

$$Y_{jt} = A_{jt} \left(\sum_{i \in I_{jt}} X_{it} \right)^{1-\alpha} \equiv A_{jt} X_{jt}^{1-\alpha}$$

Spot-market equilibrium

- The labor market is organized through wages $\tilde{w}_{jt}$ per efficiency unit of labor, leading to individual wages $w_{ijt} = \tilde{w}_{jt} \cdot x_{it}$.
- Workers choose their employer by maximizing their utility

$$j(i,t) = \arg\max_{j} u_{ij}(W_{ijt})$$

- Firms choose wages $\tilde{w}_{jt}$ to maximize profits, taking all other wages $(\tilde{w}_{-j,t})$ as given, but considering the labor supply curve:

$$\pi_{jt} = \max_{\tilde{w}_{jt}} A_{jt} \left(X_{jt}(\tilde{W}_{1t} ... \tilde{W}_{Jt})\right)^{1-\alpha} - X_{jt}(\tilde{W}_{1t} ... \tilde{W}_{Jt}) \cdot \tilde{W}_{jt}$$

- The equilibrium is characterized by the set of wages $(\tilde{W}_{1t} ... \tilde{W}_{Jt})$ and allocations $(X_{1t} ... X_{Jt})$.

Equilibrium wages and value added

- The logistic demand gives:

$$X_{jt}(\tilde{W}_{1t}...\tilde{W}_{Jt}) = \bar{X}_t \frac{\tilde{W}_{jt}^{\beta} \cdot e^{g_j}}{\sum_{j'} \tilde{W}_{j't}^{\beta} \cdot e^{g_{j'}}}$$

- Then the first order condition for the firm gives for wages:

$$(1+\alpha\beta)\tilde{w}_{jt} = \log\frac{(1-\alpha)\,\beta}{1+\beta} + a_{jt} - \alpha \log K_t - \alpha g_j,$$

$$w_{ijt} = k_t - \frac{\alpha}{1+\alpha\beta} \cdot g_j + x_{it} + \underbrace{\frac{1}{1+\alpha\beta}}_{\text{passthrough } a\to w} a_{jt}$$

- And for value added

$$y_{jt} \simeq k_t - \frac{\alpha(1-\alpha)}{1+\alpha\beta} \cdot g_j + \underbrace{\frac{1+\beta}{1+\alpha\beta}}_{\text{passthrough } a\to y} a_{jt}$$

Deriving the estimating equation 1/3

- We consider our two measurement equations:

$$w_{ijt} = k_t - \frac{\alpha}{1+\alpha\beta} \cdot g_j + x_{it} + \frac{1}{1+\alpha\beta} a_{jt}$$

$$y_{jt} \simeq k_t - \frac{\alpha(1-\alpha)}{1+\alpha\beta} \cdot g_j + \frac{1+\beta}{1+\alpha\beta} a_{jt}$$

- We make further assumptions on the process for x_{it} and a_{jt}:
  - $a_{jt} = a^p_{jt} + u^*_{jt}$ with $a^p_{jt} = a^p_{jt-1} + \xi^*_{jt}$
  - $x_{it} = x^p_{it} + v_{it}$ with $x^p_{it} = x^p_{it-1} + \mu_{it}$

Deriving the estimating equation 2/3

- Following the literature (Guiso, Pistaferri, and Schivardi, 2005), we focus on stayers:

$$\mathbb{E}\left[w_{it}|j(i,\tau)=j,\tau=1..T\right] = k_t - \frac{\alpha}{1+\alpha\beta}\cdot g_j + \frac{1}{1+\alpha\beta}\log a_{jt} + \mathbb{E}\left[x_{it}|j(i,\tau)=j,\tau=1..T\right]$$

- Note that

$$Pr[j(i,t)=j|\tilde{w}_{1t}...\tilde{w}_{Jt}] = \frac{\exp\left(\beta a_{jt}+\beta x_{it}\right)}{\sum_{j'}\exp\left(\beta a_{j't}+\beta x_{it}\right)} = \frac{a_{jt}^{\beta}\cdot e^{g_j}}{\sum_{j'} a_{j't}^{\beta}\cdot e^{g_{j'}}}$$

- Since the returns to x_{it} are proportional in all firms, the mobility decision is orthogonal to the individual productivity shocks.

Deriving the estimating equation 3/3

- To eliminate g_j and take out aggregate shocks k_t, we take first differences net of time dummies:

$$\begin{aligned}\mathbb{E}[\Delta w_{it}|j(i,\tau)=j,\tau=1..T] &= \Delta x_{it}+\frac{1}{1+\alpha\beta}\Delta a_{jt}\\ &= \mu_{it}+\Delta u_{it}+\frac{1}{1+\alpha\beta}\xi^*_{jt}+\frac{1}{1+\alpha\beta}\Delta v^*_{jt}\end{aligned}$$

- The covariance structure of earnings identifies:

$$\sigma^2_\mu, \sigma^2_v \text{ and } \frac{\sigma^2_{\xi^*}}{(1+\alpha\beta)^2}, \frac{\sigma^2_{u^*}}{(1+\alpha\beta)^2}$$

- Using the value added in addition allows to recover the pass-through $\frac{1}{1+\beta}$!

Pass-through, labor "frictions" and reallocation

- The structural pass-through in this model is:

$$\frac{\partial w_{ijt}}{\partial y_{jt}} = \frac{\partial w_{ijt}}{\partial a_{jt}} \cdot \frac{\partial a_{jt}}{\partial y_{jt}} = \frac{1}{1+\beta}$$

  - when $\beta \to \infty$, $\epsilon_{ij} + g_j$ is less important, workers can substitute easily between firms and productivity shocks transmit less.
  - β is informative about how costly it for workers to reallocate across alternatives.

- Maximizing over J alternatives gives the following value

$$\mathbb{E} \max \epsilon_{ij} = \log J + \gamma_c$$

  - $\frac{\log J + \gamma_c}{\beta}$, log-wage to compensate for randomly reallocating.
  - $\frac{\log J + \gamma_c}{\beta} - \frac{\log sJ + \gamma_c}{\beta} = \frac{\log s}{\beta}$, log-wage to compensate shrinking J.

Pass-through and reallocation costs

	Permanent	Pass-through			Reallocation	
	Shock Std. Dev.	**Coefficient**	**Effect Size**	**J**	**Total value**	**10% change in J**
Panel A.	**Model 1: Worker and Firm**					
Firm	0.2905	0.0851	2.47%	49,025	97.4%	0.95%
Panel B.	**Model 2: Worker, Firm and Market**					
Firm						
Industry x Region						
Region						-

Some extensions

1. Sorting between workers and firm by allowing g_{ij} to be correlated with x_{i0}
   - Estimating equations unchanged
   - Provides an interpretation of AKM decomposition
2. Extended model with market level shocks
3. Heterogeneity in pass through
   - Observables heterogeneity: Workers, firms, and markets
   - Unobserved heterogeneity: β_i
4. Discrepancy in size of firm and market components in a) and b)
5. Difference in the pass through of permanent and transitory shocks
   - Firms learning about changes in productivity from changes in value added

An extended model with market level shocks

- Firms are partitioned in R groups (industries, regions, ...)
- Group level productivity is A_r and firm level is A_j and $Y_{jt} = A_{r(j)} A_j X_{jt}^{1-\alpha}$
- Preferences are distributed according a nested Logit
  - parameter ρ allows for workers to draw correlated preferences within each group r
- Equilibrium wages and value added have the following form:

$$w_{ijt} \simeq k_t - \frac{\alpha(1-\alpha)}{1+\alpha\beta} \cdot g_j + \frac{1}{1+\alpha\beta} a_{r(j),t} + \frac{\rho}{\rho+\alpha\beta} a_{jt}$$

$$y_{jt} \simeq k_t - \frac{\alpha(1-\alpha)}{1+\alpha\beta} \cdot g_j + \frac{1+\beta}{1+\alpha\beta} a_{r(j),t} + \frac{\rho+\beta}{\rho+\alpha\beta} a_{jt}$$

Market level shocks, pass-through and reallocation

- The pass-through of value added to earnings are given by
  - at the group level $\frac{1}{1+\beta}$
  - at the firm within $\frac{\rho}{\rho+\beta}$
- The total value associated with firm and group choice alternatives:

$$\mathbb{E}\max \epsilon_{ij} \simeq \underbrace{\frac{\log R}{\beta}}_{\text{region r}} + \underbrace{\rho\frac{\log \bar{J}_r}{\beta}}_{\text{firm in r}} + C$$

- When $\rho = 1$, we get back to our original formula.
- Empirically, the pass-throughs are estimated as in the one level case, using co-variance structure.

Estimated parameters of the earnings process

	Model 1	Model 2	Model 3
Panel A.	**Permanent Variance**		
Individual	0.0126	0.0090	0.0090
Firm		0.0037	0.0023
Industry x Region			0.0008
Region			0.0004
Panel B.	**Transitory Variance**		
Individual	0.0128	0.0114	0.0114
Firm		0.0014	0.0015
Industry x Region			0.0000
Region			0.0000
Panel C.	**Moving Average Coefficient**		
Individual	0.1493	0.1337	0.1337
Firm		0.2800	0.2358
Industry x Region			-
Region			-

Variance decomposition of the earnings process

	Model 1			Model 2			Model 3		
	Values	**Shares**	**Cons. Eq.**	**Values**	**Shares**	**Cons. Eq.**	**Values**	**Shares**	**Cons. Eq.**
Panel A.				**Permanent Component**					
Individual	0.0126	36.2%	-19.7%	0.0090	25.7%	-14.2%	0.0090	25.7%	-14.2%
Firm				0.0037	10.5%	-5.9%	0.0023	6.7%	-3.8%
Industry x Region							0.0008	2.2%	-1.2%
Region							0.0004	1.0%	-0.6%
Panel B.				**Transitory Component**					
Individual	0.0223	63.8%		0.0201	57.5%		0.0201	57.5%	
Firm				0.0022	6.3%		0.0024	6.9%	
Industry x Region							0	0%	
Region							0	0%	
Panel C.				**Both Components**					
Individual	0.0349	100%		0.0291	83.2%		0.0291	83.2%	
Firm				0.0059	16.8%		0.0048	13.6%	
Industry x Region							0.0008	2.2%	
Region							0.0004	1.0%	

Estimated parameters of the value-added process

	Model 1	Model 2
Panel A.	**Permanent Shock**	
Firm	0.0844	0.0463
Industry x Region		0.0152
Region		0.0187
Panel B.	**Transitory Shock**	
Firm	0.0614	0.0114
Industry x Region		0.0014
Region		0.0114
Panel C.	**Moving Average Coefficient**	
Firm	0.1493	0.1337
Industry x Region		0.2800
Region		0.1337

Pass-through and reallocation costs

	Permanent Shock Std. Dev.	Pass-through Coefficient	Pass-through Effect Size	J	Reallocation Total value	Reallocation 10% change in J
Panel A.			**Model 1**			
Firm	0.2905	0.0851	2.47%	49,025	97.4%	0.95%
Panel B.			**Model 2**			
Firm	0.2152	0.0923	1.98%	35	36.1%	0.96%
Industry x Region	0.1233	0.0886	1.09%	20	29.1%	1.02%
Region	0.1367	0.0827	1.13%	40	33.2%	1.07%

Conclusion

- We use U.S. tax data to study earnings dynamics and transmission of firm and market level shocks
- Our results will be informative about:
  - Costs to worker reallocation across firms and markets
  - Sources of inequality, and how they vary
    - over time
    - between areas
    - across the income distribution
  - Sources of attenuation or insurance:
    - tax-transfer system
    - spouses
  - The link between estimates of pass through and firm effects

Card, D., A. R. Cardoso, J. Heining, and P. Kline (2016): "Firms and Labor Market Inequality: Evidence and Some Theory," .

Guiso, L., L. Pistaferri, and F. Schivardi (2005): "Insurance within the Firm," *J. Polit. Econ.*, 113(5), 1054–1087.

Sample Selection

	Individuals		Firms	
	Unique	**6-year Spells**	**Unique**	**6-year Spells**
Panel A.	**Sample of Individuals**			
Observe W-2 for 6 years	47,094,716	281,999,136	7,381,173	
Earnings at least minimum wage	37,480,138	212,647,792	5,099,037	
Stay in the same firm	28,854,833	129,576,236	2,717,709	
Panel B.	**Sample of Individuals Matched to Firms**			
Firm present for 6 years	13,126,042	53,754,316	2,104,270	10,964,021
Firm non-missing VA	9,114,567	31,939,876	1,760,212	7,853,527
Firm positive VA	8,747,828	30,374,864	1,677,064	7,414,644
Panel C.	**Sample Satisfying Size Restrictions**			
10 workers per firm	4,720,231	14,803,134	106,122	449,090
10 firms per industry-region	2,608,182	7,688,233	61,886	249,972
10 industry-regions per region	2,170,691	6,303,437	49,025	195,1300

Notes: This table displays sample sizes when imposing sample restrictions. The final line indicates the sample used in the analysis. back

Sample Selection (Cont.)

	Industry-Region		Region	
	Unique	**6-year Spells**	**Unique**	**6-year Spells**
Panel A.	**Sample of Individuals**			
Observe W-2 for 6 years				
Earnings at least minimum wage				
Stay in the same firm				
Panel B.	**Sample of Individuals Matched to Firms**			
Firm present for 6 years	63,068	458,724	742	7,420
Firm non-missing VA	49,208	357,000	741	6,668
Firm positive VA	48,548	350,082	741	6,662
Panel C.	**Sample Satisfying Size Restrictions**			
10 workers per firm	16,501	100,149	691	5,901
10 firms per industry-region	1,381	8,791	171	1,293
10 industry-regions per region	903	5,634	40	280

Notes: This table displays sample sizes when imposing sample restrictions. The final line indicates the sample used in the analysis. back

Estimation Details

From our structural model and orthogonality conditions,

$$0 = \mathbb{E}\left[\Delta y_{jt-1}\left(\Delta y_{jt} - \lambda \Delta w_{jt}\right)\right]$$

$$\left(\gamma - \lambda\right)\sigma_{\xi}^{2} = \mathbb{E}\left[\Delta w_{jt}\Delta y_{jt} - \lambda\left(\Delta y_{jt}\right)^{2}\right]$$

where γ (λ) is the pass-through of permanent (transitory) value added shocks to wages and σ_{ξ}^{2} is the variance of permanent value added shocks. Since σ_{ξ}^{2} is identified from moments only involving value added, this is a system of two equations in the two pass-through parameters. back

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