

On the Role of Learning, Human Capital and Performance Incentives for Wages

Braz Camargo¹ Fabian Lange² Elena Pastorino³

¹Sao Paulo-FGV ²McGill University ³Stanford University and Hoover Institution

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Revisit Key Debate in Labor Economics

- To align workers' incentives to firms' objectives, firms often link compensation to performance on the job
 - through bonuses, commissions and piece rates
 - but for most, performance pay (PP) accounts for $<10\%$ of pay (not major component at any point over life cycle)
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- This well-known *career-concerns* (CC) argument (Holmström, 1982 and 1999) is common explanation
 - not only for why PP often makes up *only a small portion of pay* but also for *how PP varies over time*
 - intuitively, as workers accumulate experience and their productivity becomes better known
 - implicit incentives from CC weaken so explicit ones from PP should substitute becoming more and more important

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 - in fact, profile of PP relative to total pay is *hump-shaped* with experience in a variety of public and firm-level data sets
- Given this failure of existing models to account for basic features of data
 - how can we rationalize the pattern of PP over the life cycle?
 - do we need to account for performance incentives *at all* if PP on average accounts for no more than 10% of wages?

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 - micro-founds notion of jobs as requiring multiple tasks that are contractable to different degrees
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 - identified from panel data on wages and their fixed/variable components based on this characterization
 - reproduces dynamics of w , dispersion, their fixed-variable pay comp'n as well as workers' task-assignments profiles

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 - reproduces dynamics of w , dispersion, their fixed-variable pay comp'n as well as workers' task-assignments profiles
- Demonstrate our model resolves puzzle on level and variability of PP
 - PP is *low* for insurance reasons to mitigate workers' *correlated life-cycle wage risk* due to uncertainty about their ability
 - eventually \downarrow whenever effort to produce output \uparrow HK (once HK less valuable, impl./expl. incentives optimally lower)
 - find PP central to dynamics of w : contributes $\approx 30\%$ of growth and variability in w over first 10 to 20 yrs of experience

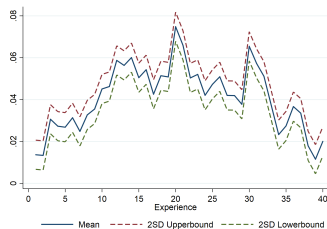
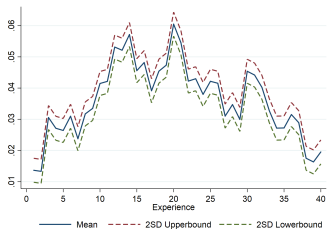
Data

- We use public worker panel data (PSID, NLSY79 and NLSY97) and confidential firm personnel records
 - from three influential studies in the literature (Baker-Gibbs-Holmström 1994a,b, Gibbs-Hendricks 2004)
 - to provide evidence on experience profile of wages and fixed/variable components
- In all samples: wages (labor earnings) are given by sum of fixed f_t and variable v_t pay: $w_t = f_t + v_t$
 - since in our model variable pay v_t is proportional to performance y_t via piece rate b_t : $v_t = b_t y_t$
 - can measure sensitivity of pay to performance b_t as $\mathbb{E}(v_t)/\mathbb{E}(w_t)$ under the assumption of free entry ($\mathbb{E}(w_t) = \mathbb{E}(y_t)$)
- Based on these data spanning across different years, workers and firms
 - we document ratio of PP to total eventually *declines* with experience
 - contrary to the prediction of CC models with explicit incentives

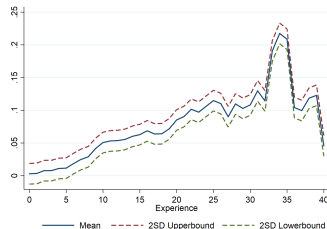
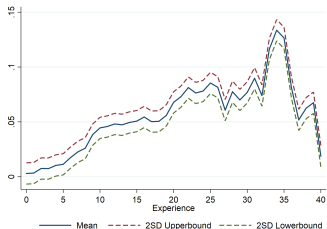
Next: for today will focus on our two firm-level data sets

In Both Data Experience Profile of Sensitivity Hump-Shaped

Managers and College-Educated Managers in BGH Sample



White-Collar Workers and College-Educated White-Collar Workers in GH Sample



Next: present model we propose to account for these patterns

Model

Competitive Labor Market

- Over finite horizon populated by homogeneous risk-neutral firms (can relax) and heterogeneous workers
 - workers have CARA preferences with parameter r nonsep. over time: $-\exp\{-r[\sum_{t=0}^T \delta^t (w_t - e_{1t}^2/2 - e_{2t}^2/2)]\}$
 - so workers indifferent among all deterministic wage streams with constant PV (as in Gibbons and Murphy, 1992)
 - * note: cost of effort quadratic (second derivative set to 1 for ease of exposition and reasons of identification)
- Workers each period exert two types of effort
 - on *simple tasks* e_{1t} easy to monitor (*contractable*): entail creating/selling products or direct contacts with clients
 - on *complex tasks* e_{2t} difficult to monitor (*non-contractable*): entail managing large groups or strategic planning

→ we think of firms' *jobs* as primitive bundles of simple and complex tasks (continuum of them)
- Firms compete by offering one-period wage contracts linear in worker's output y_t
 - recall wage in any t , $w_t(y_t) = f_t + b_t y_t$, sum of fixed f_t and variable $v_t = b_t y_t$ pay
 - assuming long-term contracts infeasible equivalent to feasible but renegotiation-proof (reneg'd if Pareto inefficient)

Output Technology, Ability and Information

- Worker (log) output at any t depends (log linearly) on worker ability, HK and effort and is subject to shocks
 - $y_t = \theta_t + \xi_k k_t + \xi_1 e_{1t} + \xi_2 e_{2t} + \varepsilon_t$ (e.g. $\xi_k = \xi_1 = 0$: CC; $\xi_k = \xi_1 = \xi_2 = 0$: learning; all known: labor S and HK)
 - whereas ability θ_t is unobserved to all, human capital k_t and effort e_{2t} on *complex tasks* are observed *only* to worker

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- $\theta_{t+1} = \theta_t + \zeta_t$: ability θ_t evolves over time according to random walk (uncertainty renewed through ζ_t)
 - θ_0 normal mean-zero w/ variance σ_θ^2 and ζ_t normal mean-zero w/ variance σ_ζ^2 (alternatively, shock to HK)

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- $k_{t+1} = \lambda k_t + \gamma_1 e_{1t} + \gamma_2 e_{2t} + \beta_t$: HK accumulates with **effort** in each task at rates (γ_1, γ_2) (LBD or LOD)
 - depreciates at rate $1 - \lambda$ (can allow for semiparametric law $k_{t+1} = \lambda k_t + F(e_{1t}, e_{2t})$)

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 - depreciates at rate $1 - \lambda$ (can allow for semiparametric law $k_{t+1} = \lambda k_t + F(e_{1t}, e_{2t})$)
- At end of each period t : beliefs about θ_t are updated based on realized y_t according to Bayes' rule
 - given worker's conjectured \hat{k}_t and $(\hat{e}_{1t}, \hat{e}_{2t})$: $z_t = y_t - \xi_k \hat{k}_t - \xi_1 \hat{e}_{1t} - \xi_2 \hat{e}_{2t}$ is signal about θ_t extracted from y_t
 - so workers have an incentive to exert effort to affect signal z_t and so market beliefs about θ_t (CC incentive for effort)

Next: turn to characterize sensitivity of pay to performance

Sensitivity of Pay to Performance Implied by Model

- Given by $b_t^* = b_t^0 \left[1 - \underbrace{R_{CC,t}^*}_{(1)} - \underbrace{rH_t^*}_{(2)} + \underbrace{\gamma_{2t} \sum_{\tau=1}^{T-1} \delta^\tau \lambda^{\tau-1} - R_{LBD,t}^*}_{(3)} \right]$ where
 - scaling factor $b_t^0 = 1/[1 + r(\sigma_t^2 + \sigma_\varepsilon^2)]$ is standard piece rate from static (linear normal) MH models
 - so optimal b_t^* differs from static one due to last three terms
 - * first two are negative so **depress** piece rates relative to static level
 - * last has **ambiguous** effect: consists of positive and negative term (if $\gamma_{2t} > 0$ as we estimate)
- Note that if workers were risk neutral, $b_t^* = 1$ so v_t would move 1-1 with y_t
 - since workers are risk averse, firms optimally provide incentives by smoothing variability of w over time
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- $R_{CC,t}^* = \sum_{\tau=1}^{T-t} \delta^\tau (1 - b_{t+\tau}^*) \partial \mathbb{E}_t(\theta_{t+\tau}) / \partial e_{2t}$: CC provide implicit effort incentives even in absence of PP
 - so by partially substituting for explicit incentives lead to lower piece rates

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- $rH_t^* = r\sigma_t^2 \sum_{\tau=1}^{T-t} \delta^\tau$: captures insurance against wage risk due to uncertainty via \downarrow piece rates
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 - **first**: accounts for impact of effort on future output (social marginal return)
 - **second**: accounts for HK implicitly incentivizing e_{2t} (private marginal return) so partially substitutes for explicit incent's
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Next: experience profile of $\{b_t^*\}$ naturally depends on relative strength of all these forces

Alternative Profiles of Sensitivity of Pay to Performance Possible

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- Combined model inherits both forces so can lead to profile for b_t^*
 - **hump-shaped**: if LBD-HK motives *weaker* than uncertainty at low levels of experience (σ_θ^2 large, σ_ζ^2 small, T large)
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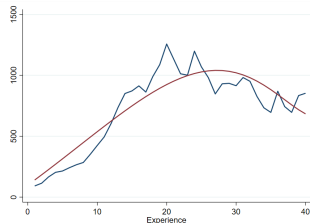
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- Based on these arguments, prove model identified
 - key intuition: equilibrium b_t^* provides known mapping btw PP and worker preference/HK parameters (as we saw)

Estimation Results

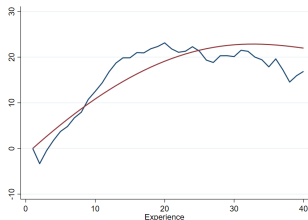
Estimates of Model on Firm-Level Data From BGH

- With fixed δ : we estimate 9 remaining parameters ($\sigma_\theta^2, \sigma_\zeta^2, \sigma_\varepsilon^2, \gamma_1, \gamma_2, \lambda, r$) by MD targeting 120 moments
- Corresponding to w variance, cumulative w growth and b_t^* over first 40 years of experience

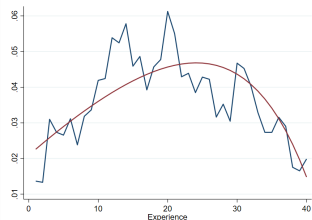
(a) Wage Variance



(b) Wage Growth



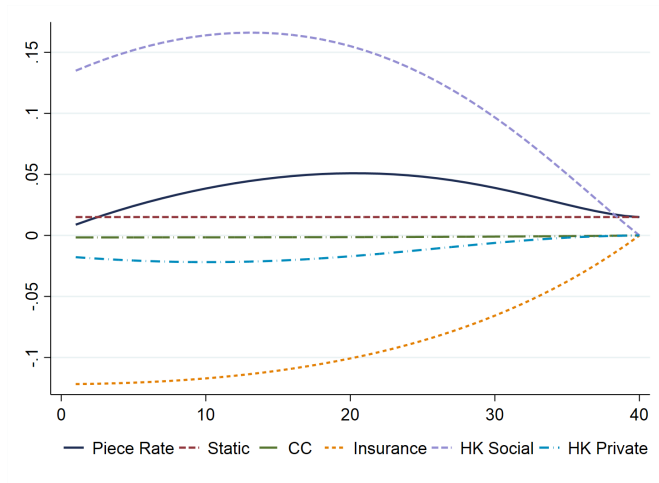
(c) Piece Rates



- As apparent from figure: model closely matches all these dimensions of data (very precisely)
- Based on estimates: can decompose estimated b_t^* into the five components isolated earlier

Decompose Estimated Piece Rate at Each Experience

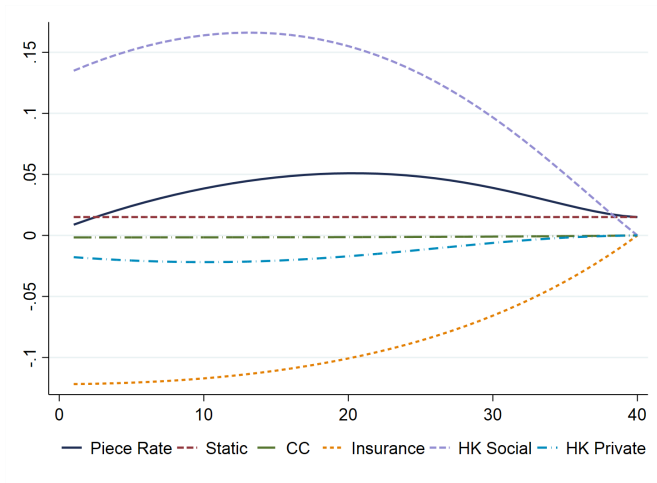
Into components due to: static piece rate, CC, insurance, HK social and HK private return



Find key components: HK social and insurance vs. uncertainty about θ_t (figure: remaining negligible)

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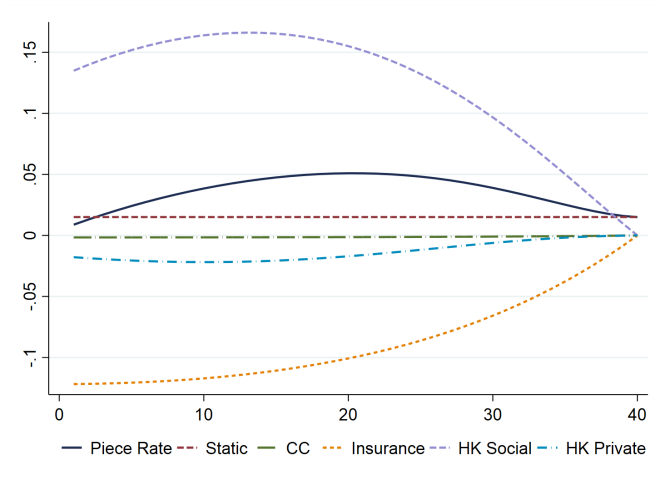
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HK social, which is large and positive, important to account for hump shape of piece rates

Decompose Estimated Piece Rate at Each Experience

Into components due to: static piece rate, CC, insurance, HK social and HK private return



Insurance against uncertainty about θ_t , which is fairly large and negative term, explains low level

Can Interpret Decomposition in Light of Estimates

- A robust findings of different parameterizations of our model (e.g. imposing fast or slow learning)
 - output shocks must be large relative to uncertainty about ability for b_t^* and variance of w to be \downarrow later in life
 - as apparent from $\text{Var}[w_{it}] = \sigma_\theta^2 + t\sigma_\zeta^2 - \sigma_t^2 + (b_t^*)^2(\sigma_t^2 + \sigma_\varepsilon^2)$ (hump shape of b_t^* translates into one for $\text{Var}[w_{it}]$)

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 - * this explains why remaining terms are small: CC incentives and static piece rate $b_t^0 = 1/[1 + r(\sigma_t^2 + \sigma_\varepsilon^2)]$
 - * and so is private marginal return to HK (since \propto to CC incentives and piece rates)

Can Interpret Decomposition in Light of Estimates

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 - contracts with v_t pay out more when y_t high (so news about θ_t are positive) and MU_C low
 - thus exhibit *opposite covariance* structure of returns (btw y_t , current and future wages) than risk-averse investors desire
 - low b_t^* \downarrow ability risk by \downarrow correlation btw current and future w (insurance against life-cycle risk from uncer'y about θ_t)

Next: discuss role of performance incentives for wage growth ($w_t - w_1$ in thousands \$) and dispersion

What Accounts for Lifecycle Wage Growth?

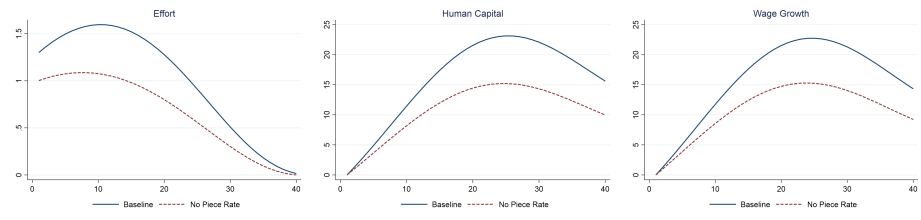


As w growth is sum growth in HK and effort, can decompose in contribution of each: HK accounts for nearly all

Decomposition Masks Impact Effort on Human Capital

But effort has important *indirect* effect on w growth as active margin of investment in HK (find it of the LBD type)

One way to see how e_{2t} matters: assume firms restricted to offer contracts w/o variable pay

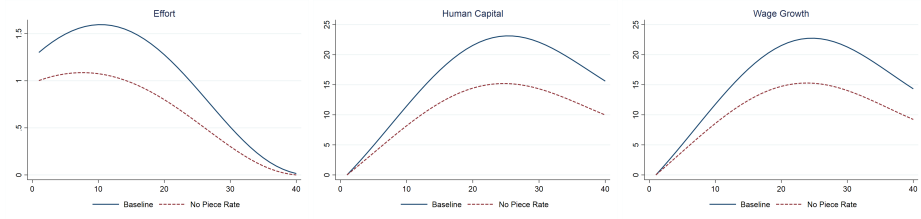


W/o p-incentives ($b_t^* = 0$): e_{2t} and k_t much lower would lead to **30% ↓ growth** (see red vs. blue)

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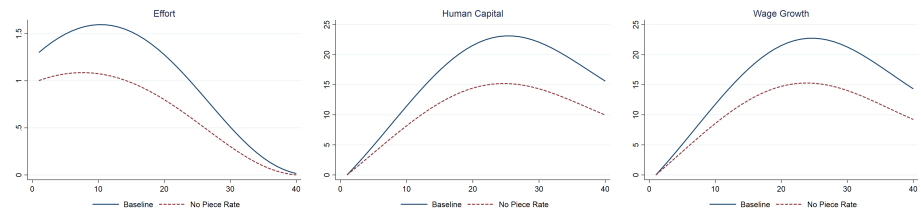


So performance incentives *matter* for wage growth

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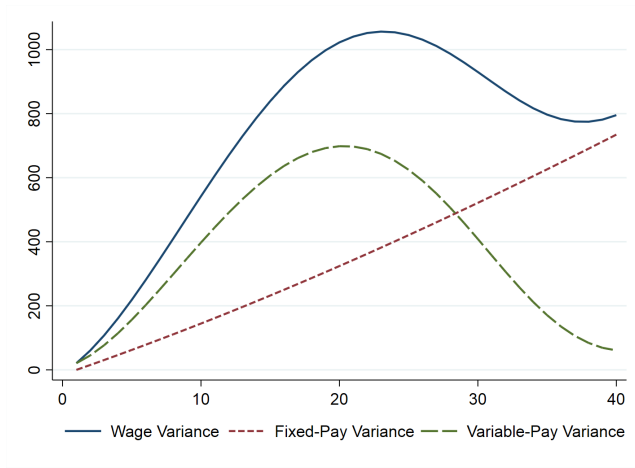
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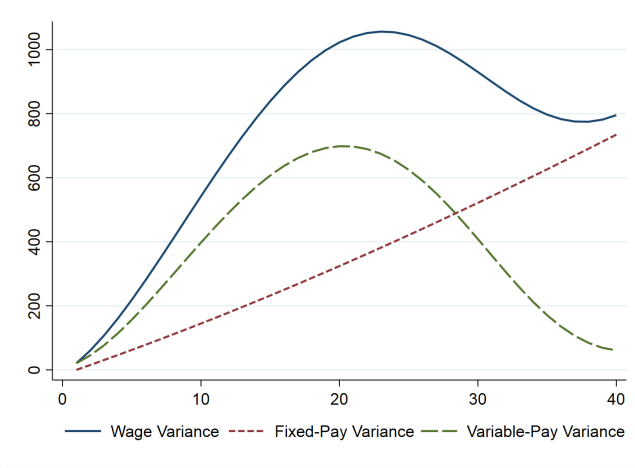
So performance incentives *matter* for wage growth. Do they matter for wage dispersion?

Although Small Variable Pay Also Key to Variance of Wages



Over lifecycle: as apparent from decomposing it into contribution of fixed and variable components of pay (figure)

Although Small Variable Pay Also Key to Variance of Wages



Indeed variance v_t alone (green) accounts for no less than 35% of variance w_t (blue) over first 20 years

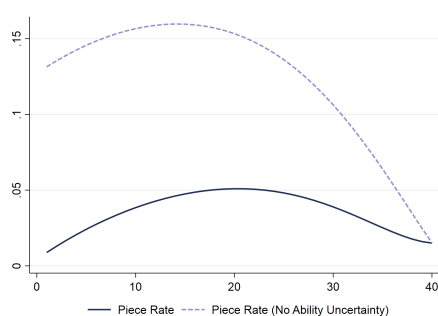
How Important Is Ability Uncertainty for Wage Dispersion?



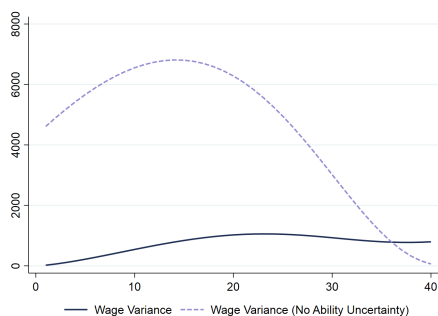
At the **estimated equilibrium** $\{b_t^*\}$: large fraction of w variance accounted by it ($\sigma_\theta^2 = \sigma_\zeta^2 = 0$)

But Lowering Ability Uncertainty Would Not Lower Wage Dispersion

(d) Piece Rates



(e) Wage Variance



Why? Workers demand **less insurance** so firms **offer higher b_t^*** : amplify risk leading to *much* \uparrow variability (4 times)

What Do We Learn From This Experiment?

- Much evidence points to heterogeneity in ability as important source of persistent w inequality among workers
- But wage structure is itself determined by this heterogeneity
- In particular \downarrow it can actually lead to $\uparrow w$ dispersion by inducing firms to offer wages more sensitive to y_t

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- Key idea: wage structure is important endogenous transmission mechanism of shocks to wages

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- These results validate the incentives, human capital and uncertainty mechanisms at the heart of our model

Conclusion

- We have proposed new model of learning, HK and performance incentives to account for
 - overall **level** of wages, their **dispersion**, their **composition** in terms of fixed and variable pay and **dynamics**
 - which *rationalizes puzzle* that ratio of variable to total pay *declines* over second half of life cycle
- We have characterized optimal wage contract and based on this characterization
 - isolated the *distinct determinants* of the level and experience profile of PP relative to total pay
 - proved *model identified* just from panel data on w and their fixed or variable components
- Our estimation results show
 - insurance against *life-cycle wage risk arising from uncertainty about ability* is main reason for low PP
 - yet performance incentives key to dynamics of overall wages *both directly and through impact on workers' HK process*
- Hope first step toward richer models of incentives to interpret sources of dispersion in wages and its persistence