Capitalist competition drives wage inequality: empirical evidence and econo-physics modeling

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Competition and inequality are ubiquitous and defining features of capitalism. My presentation to the GAPE web seminar series spans my entire dissertation project, in which I develop a Classical Political Economics theory of wage inequality. My work extends Anwar Shaikh's model of real competition and Howard Botwinick's application to persistent industrial wage inequalities.

Botwinick derived persistent wage inequalities from turbulent profit rate dynamics. I add a dynamic of turbulent equalization of wages and provide empirical evidence on the industry aggregate as well as the individual worker level. The turbulent processes in firm profits and worker wages are linked, with a significant and substantial impact of regulating profit rates on wage increases.

I argue that the intertwined processes are the link between competition and inequality and present a stochastic differential equation model (sometimes referred to as drift-diffusion, Fokker-Planck equation or Kolmogorov forward equation model) of wage increases as the mathematical explanation for the stationary distribution of wages. When I calibrate a simple SDE with US wage data (Funk 2012), the corresponding parameter transformation to the cross-sectional Gamma probability density function (Fischer 2018) is very close to the empirical inter-industry wage distribution.

The results suggest that, as Marx put in the Grundrisse, "*competition among workers is only another form of the competition among capitalists*" in three ways. (Marx 1999, 651) The dynamics of profits and wages (1) follow a similar pattern, (2) the wage dynamic is induced by firm dynamics and (3), the interaction of the two provide an explanatory model for the form and extent of wage inequality in capitalism.

Wages are turbulently equalizing

Inter-industry wage differentials, ie. workers with the same occupation, demographic and education earning different wages, are an instructive "pure" example of wage inequality. At the same time, persistent differences in average profit rates can be explained in the "real competition" literature by the turbulent equalization of profit rates on new capital ("regulating profit rates"), and persistently differential turnover speed of capital as differential cost structures. Shaikh's theory of turbulent equalization (Shaikh 1980, 2016) is a modern application of Marx' work on the general profit rate in Volume 3 (Marx 1991), where perpetual attempts of capitalist to increase profit rates above the general rate (the disorder of the system) only bring upon this rate (the order of the system). Vaona and Tescari (Vaona 2011; Tescari and Vaona 2014) provide an empirical test for turbulent equalization or regulating profit rates, building on Mueller's work on persistent differentials in average profit rates.

Following their method, we find that industrial wage increases participate in turbulent equalization in a majority of US industries. (Mokre and Rehm 2020). The industries participating in turbulent equalization of both profit rates and wage increases employ more than 80 % of the regular US workforce. (Mokre 2021, 24). I restrict the studies in my dissertation on those industries.

Turbulent processes are a concept borrowed from fluid dynamics. They are highly unsteady (at any given time, their velocity “would appear random”) but contain coherent structures (“repeatable and essentially deterministic”). (Ferziger and Perić 2002, 265) The Vaona test shows regulating profit rates to be turbulently equalizing if a moving average regression shows no significant intercept term nor regression coefficients on non-linear transformations of time. This matches the “highly unsteady” component of the definition. In a hierarchical panel regression, we find significant effects of the current and lagged regulating profit rate, output and capital intensity on wage increases. This matches the coherent component, and at the same time suggests that firm competition impacts wage inequality.

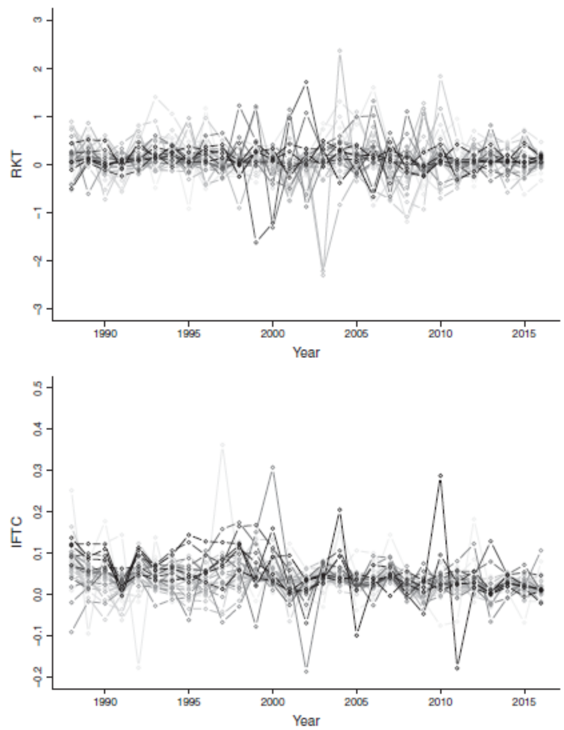

Figure 1: Profits and Wages are turbulently equalizing. Deviations of regulating rates of return (top) and incremental wages (bottom) from yearly averages for 48 industries, 1987–2016. Mokre and Rehm 2020, Figure 2

The impact of competition is strongest in the Extremes

Botwinick (1993) derives limits to wage growth in bargaining (capitalists’ ability to pay) consistent with real competition, namely capital intensity and the share of labor cost in total cost. The first limit is a result of competition between industries, while the second stems from competition within industries. In Mokre and Rehm (2020), we find a positive impact of capital intensity on industrial wage inequality, consistent with this theory (as is the impact of current and lagged regulating profit rates). Since I perform the empirical analysis on industry averages, it remains unclear if the results are carried by high-earning, quasi-managerial workers enjoying profit sharing in the form of bonuses or stock options.

In Mokre (2021) I extend the analysis to the worker individual level using the CPS outgoing rotation group sample. Quantile regression analysis (Koenker and Bassett 1978) provides insight into the differential impacts of competition on low, medium and high earners. The richer dataset also allows me to control for individual characteristics.

I find persistent and significant wage industrial wage differentials in all three wage groups. Furthermore, capital intensity and the share of labor cost in total cost have a positive impact on wage levels on all 10 % quantiles of the wage distribution. Competition between industries has the biggest impact around the median, while competition within industries is most effective at the very top.

The turbulently equalizing regulating profit rates have a substantial and significant impact on the equally turbulently equalizing wage increases at all 10 % quantiles, consistent with the findings in Mokre and Rehm (2020). However, the coefficients in the lower three and upper 4 deciles are almost three times as high than at the median in some sort of U-shape. The link of turbulent equalization is strongest in the extremes.

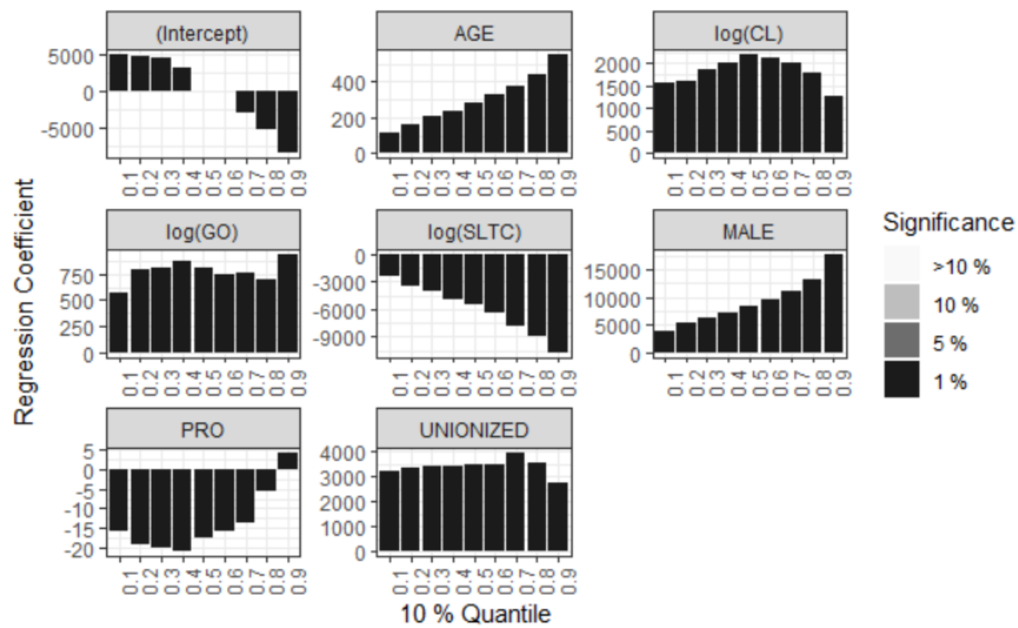

Figure 5: Coefficients for Structural Variables on the Industrial Level in Conditional Quantile Regression of Wage Levels. Data: IPUMS CPS, Full Time Employees, and BEA Industry Accounts, 1998-2018.

Figure 2: Competition between (CL) and within (SLTC) industries have a persistent impact on wage levels. Coefficients for Structural Variables on the Industrial Level in Conditional Quantile Regression of Wage Levels. Data: IPUMS CPS, Full Time Employees, and BEA Industry Accounts, 1998-2018. Mokre 2021, Figure 5

Turbulent equalization explains stable inequality

Stochastic differential equations (SDE) describe growth processes as the product of one deterministic drift and one stochastic diffusion component. The intuition to link random growth process to stable level distributions can be found in industrial economics (Gibrat 1931), financial economics (Vasicek 1977; Cox, Ingersoll, and Ross 1985) and inequality economics (Modigliani 1986; Piketty and Saez 2012; Gabaix et al. 2016). Recently, SDE modeling of growth processes has been applied to models of income inequality (Drăgulescu and Yakovenko 2001; Fischer 2018; Shaikh 2020).

The mathematical intuition of the SDE modeling is consistent with the Classical Political Economics modeling of economic systems wherein the order emerges from the disorder of agents defecting from it. A simple SDE from financial economics is the Cox-Ingersoll-Ross model of interest rates, with a mean reverting drift process and a Wiener diffusion process.

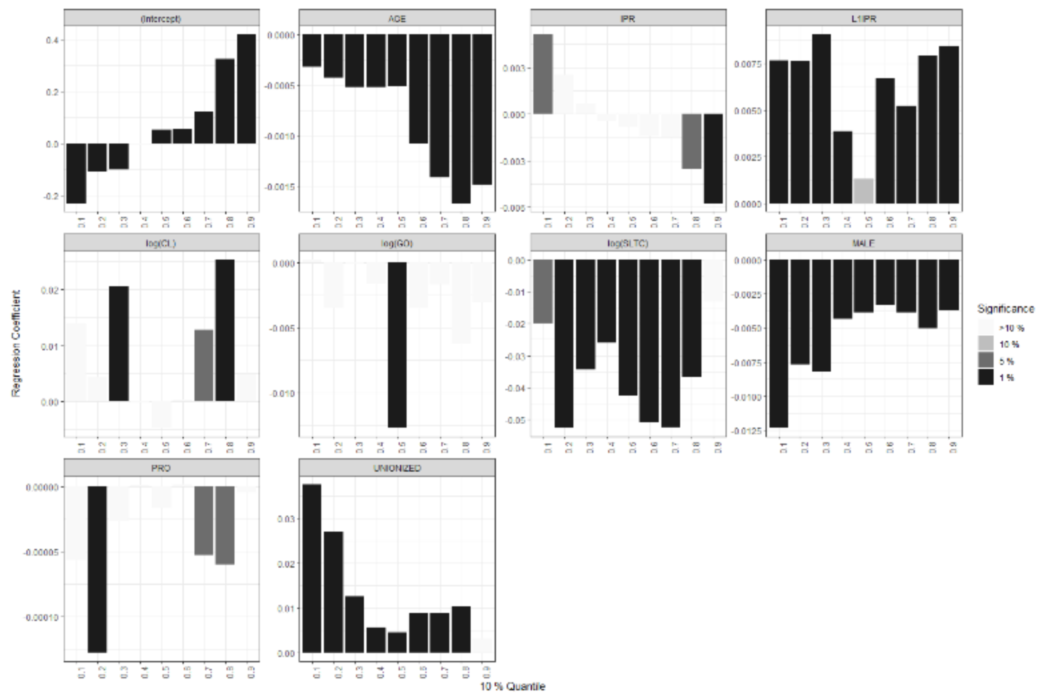

Figure 6: Conditional Quantile Regression, Impacts of Demographic and Structural Factors on year-to-year Wage Increases.

Figure 3: The regulating profit rate (L1IPR) has a signifcant impact on wage increases. Conditional Quantile Regression, Impacts of Demographic and Structural Factors on year-to-year Wage Increases. Mokre 2021, Figure 6

$$dX_t = \theta(\mu - X_t) + \sigma\sqrt{X_t}dW_t \quad (1)$$

In economics, a drift diffusion model allows to explicitly model arbitrage, ie. competitive action. For example, when firms observe an above-average profit rate on new capital ("regulating profit rate") in some industry, investment to this industry will accelerate. This increases supply relative to demand, diminishes prices and pushes the expected profit rate below the average, reverting the investment stream. This arbitrage gives the characteristic "crossing over" pattern of regulating profit rates, seemingly random as in fluid dynamics turbulent processes. The diffusion component directly models this. At the same time, the constant crossing-over has a common center of gravitation in the general profit rate on new capital. The larger the deviation, the more pronounced are the resulting competitive dynamics. The mean reverting drift component captures this.

Shaikh and Jacobo (2019) propose to apply the same logic to wage incomes. Industries offering above-average wages would attract workers, increasing labor supply relative to demand which sets in motion the same dynamic as above. However, firms' wage offers are not determined only on the labor market, but rather by investment increasing labor demand as well as higher regulating profit rates shifting the limits to wage growth in bargaining (Slichter 1950; Botwinick 1993). I argue that the turbulent dynamics of capital and labor are linked by capitalists ability to increase wages in bargaining. The competitive dynamics of firms set the field for the competitive dynamics of workers.

A Cox-Ingersoll-Ross process has a stable cross-sectional non-centered Chi-Squared distribution of levels. Asymptotically, it converges to a Gamma distribution, with an analytic parameter transformation of CIR parameters θ, μ and σ to Gamma shape α and rate β. (Fischer 2018, 45) I fit a CIR process to US wage increases 1991-2018 (normalized by the yearly average), and independently, a Gamma distribution to wage levels over the same time (Funk 2012).

I start with industrial inequality and fit the model to industrial average income. The parameter transformation gives $\alpha = \beta = 24.01$, which is surprisingly consistent with the best fit empirical parameters of $\hat{\alpha} = \hat{\beta} = 24.06$. The drift diffusion model seems to aptly capture the dynamics of inter-industrial competition and inequality.

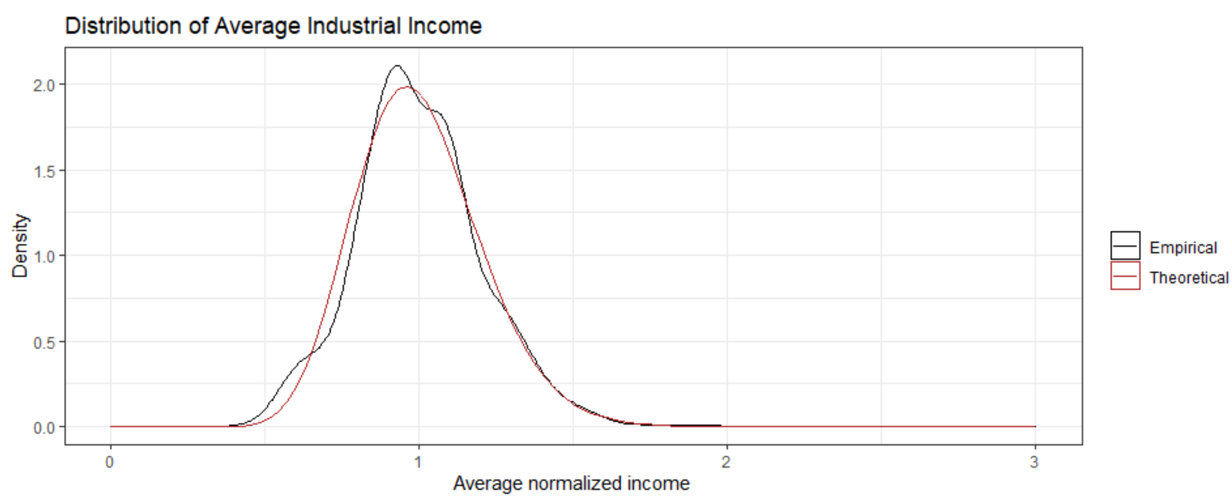

Figure 4: Empirical Density and calibrated Gamma PDF of industrial average incomes.

On the worker individual level, the fit is worse, with CIR-derived parameters $\alpha = 1.18$ and $\beta = 1.2$ as opposed to $\hat{\alpha} = 2.23$ and $\hat{\beta} = 2.27$. This suggests that the simultaneous dynamics of capital and labor require a more complex model in order to explain inter-personal wage inequality.

Conclusion

In my dissertation, I inquire three aspects of Marx' argument that "*competition among workers is only another form of the competition among capitalists*." I find that the wages show similar competitive patterns as profit rates, that the latter can help explain the dynamics of the former, and that explicit modeling of the turbulent processes provide high explanatory power for inter-industrial income inequality. This provides a point of departure for a Classical Political Economics theory of wage inequality, embedded in the theory of real competition. It also offers empirical support to earlier theoretical findings in the literature and the subsequent policy advice for trade union organizing and bargaining.

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