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## Economics of unlimited supply of labor and asymmetric power

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**Economics of Unlimited Supply of Labor and Asymmetric Power**

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Working Paper No: 2015-01

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# Economics of Unlimited Supply of Labor and Asymmetric Power

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## Abstract

Since around 2000 the education premium and the level of employment in high-skill occupations has stagnated, if not actually begun to shrink. This brings into question the generally held view that in advanced countries, while potentially harmful for those who work with their hands, globalization and technological change benefit those who work with their minds. The paper argues that these unexpected labor market trends are the result not so much of autonomous changes in technology as much as they are that of the large power asymmetry between capital and labor that developed in the last few decades. The global oversupply of labor appears to have revived a pattern of skill replacing technological change that is reminiscent of 19<sup>th</sup> century capitalism. The relative abundance of cheap labor creates an incentive to chip away whatever component can be routinized from complex tasks that are performed by expensive skilled workers so that they can be offshored and automated. The paper develops a game theoretical definition of asymmetric power and shows why in labor markets characterized by a structural imbalance between supply and demand, market exchange ceases to be a positive-sum game, and how that can favor skill replacing technological change over one that augments skills. While autonomous innovations determine what non-routine task can at all be transformed into routine ones, the attractiveness of doing so is not independent of major shifts in labor market conditions.

**Keywords:** power in exchange, asymmetric power, institutional economics, skill-biased technological change, deskilling, globalization

**JEL Classification:** F60; J60; O33; D74; C72; B14; B25

## Introduction

Globalization and technological change might have precipitated an oversupply of labor around the globe, giving rise to conditions reminiscent of Arthur Lewis's "unlimited supply of labor"<sup>1</sup> in advanced countries, where no positive market clearing real wage might exist for certain grades of labor; or, if it does, it falls significantly short of covering the cost of living associated with the bare minimum socially accepted standard of living. In a world where the ongoing threat posed to employment by offshoring has reached alarming proportions (Blinder 2006, 2007), the gap between supply and demand is impervious to any price adjustments that remain within the bounds of what is socially and politically viable. A global revival of growth could potentially soak up the excess labor, but that appears increasingly unlikely. The recovery from the Great Recession remains globally anemic, and more importantly we might be at the threshold of a new wave of labor displacing innovations as the pace of automation accelerates (Brynjolfsson & McAfee 2011, 2014; Ford 2009, 2015). Economists are generally known for their skepticism with respect to the possibility of technological unemployment for they believe that just as technological change destroys some jobs it also creates others that over time more than compensate its initial negative impact. An increasing number of prominent economists, however, fear that this time around it might be different and foresee an employment crisis (Summers 2013, Spence 2014, Sachs & Kotlikoff 2012).

Economists' explanations of the effect of innovations on the labor market have been noteworthy for their technological determinism. It is generally agreed that the return on education has risen steadily throughout much of the 20<sup>th</sup> century and that is taken as *prima facie* evidence that technological change complements skills, augmenting worker productivity (Acemoglu 2002, Goldin & Katz 2010, Hamermesh 1993). According to this view, the education premium on skilled workers' wages is the result of a race between education and technological change (Tinbergen 1975, Goldin & Katz 2010), determined by the balance between the demand for skilled workers, increasing with technological change which enhances their productivity, and their supply, rising with education. Revised to account for recent disparate labor market trends (Acemoglu & Autor 2011, 2012), it still informs the way many economists conceptualize the labor market effect of technological change.

Throughout the 1990s, employment growth remained robust in the US in the face of rapid diffusion of information technologies (Krueger & Solow 2002). Technology replaced mainly mid-wage, mid-skill level routine jobs, and employment growth centered on non-routine jobs hard to computerize, both low and high skill, polarizing employment growth between 'good' and 'bad' occupations (Autor 2014; Autor, Katz & Kearney 2006). Increased investment in education and improvements in human capital appeared to be the ticket to 'good' jobs, and became the main focus of recommended economic policy. Since around 2000, however, employment growth slowed markedly (Moffitt 2012) and job losses in manufacturing accelerated (Charles et al 2012, Pierce & Schott 2014). At the same time, the (college) education premium and the level of employment in high-skill occupations has stagnated, if not actually begun to shrink. The skill profile of jobs replaced in the middle spectrum in the meantime kept rising, while low-skill, mostly manual, non-routine jobs accounted for virtually all new employment (Beaudry, Green & Sand 2013, 2014; Autor 2014; Mishel, Shierholz & Schmitt 2013).

These labor market trends raise the possibility that the effect of technological change on skills might have been time variant. It is recognized that during the 19<sup>th</sup> and early 20<sup>th</sup> centuries technological change was predominantly skill replacing (Cain & Paterson 1986, James & Skinner 1985), and that could have been

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<sup>1</sup> The term originates from Arthur Lewis's (1954) seminal work. For a broad discussion of global conditions that led to the oversupply of labor, Alpert (2013).

related to oversupply of labor (Acemoglu 2002). The reemergence of similar labor market conditions in advanced market economies might have revived this earlier pattern. In support of this view, this paper argues that conditions of unlimited supply of labor give rise to asymmetric power between capital and labor which alters the very nature of labor exchange. It shows why in such lopsided markets, characterized by a structural imbalance between supply and demand, market exchange ceases to be a positive-sum game, and how that can favor skill replacing technological change over one that augments skills.

The paper is organized in four sections and a brief conclusion. Section I defines *asymmetric power* and discusses why its presence can transform market exchange from a positive-sum to a zero-sum game, such that the potential mutual benefits of private exchange cannot be realized in full. Section II argues that with an oversupply of labor the return to labor depends not on its productivity, marginal or average, but the *enforcement rent* that can induce workers to stay on the job. Workers' ability to *walk away* and how costly job termination is to employers given their technology and its commensurate labor process determine their pay. Section III briefly revisits a couple of themes from Marx's analysis of technological change that seem to have relevance in our era. One is the notion that reorganization of work precedes and is often a precondition of automation, while the other ties the incentive to do so to labor market conditions. Section IV draws on this discussion to show how in an economy where both types of technological change (skill replacing and augmenting) coexist the increasing power asymmetry between capital and labor can favor one over the other. The paper concludes that the increased asymmetry of power between capital and labor is an important part of the explanation of recent employment trends such as the increasing paucity of high skill jobs.

## I. Exchange with Asymmetric Power

Economists have long studied market power extensively, but paid little attention to other possible forms of power asymmetry between trading parties in market exchange. Non-market power differences in voluntary exchange were thought unimportant as economic theorizing traditionally focused on prices that cleared markets and satisfied certain balancing input-output relations in equilibrium. However, that might be changing. With the growing recent interest in institutions the focus of economic theory has been shifting away from the Walrasian depiction of markets and issues thereof towards strategic behavior in *complex* transactions, and their interaction with how markets are governed.<sup>2</sup> In every market that does not clear, the old Walrasian insight holds that a potential exists for mutually beneficial trades. Individuals' failure to exploit them is now tied not so much to market imperfections *per se* but to the intricacies of strategic behavior under conditions characterized by information asymmetries or yet other difficulties of collective action.

Strategic behavior in post-Walrasian markets also entails trading parties contesting the very ground rules that govern their exchange by trying to enforce claims on each other (Bowles & Gintis 1993). The very welfare properties of private exchange then depend upon how transaction and other collective costs associated with 'enforcement and market making' are discharged by a third party enforcer or divvied up between traders. Of crucial importance among them are those collective costs related to the enforcement of property rights and contracts since the very viability and efficiency of private exchange rests upon them. The question is what happens when the collective costs of market exchange are borne inequitably

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<sup>2</sup> See Bowles and Gintis (1999) for a broader discussion.

by traders or discharged by a third party that is vulnerable to “capture” by one side, and what adverse effects that can have. In trying to answer such questions asymmetric power is clearly hard to ignore.

For the purposes of this paper, *power asymmetry* is defined within the confines of voluntary peaceable exchange where basic protection of property rights is not in doubt. In simple game theoretical terms it refers to a situation where players’ ability to adversely influence each other’s payoff is asymmetric. That is, one side through its actions can influence the other players’ payoff much more than the other can that of the first. This results from the discrepancy in the relative worth of the respective players’ second best option in relation to their first. One side’s second best option is almost as attractive as her first, while the other side’s is much inferior. For instance, in a lopsided market, what is in offer for exchange can fall short of the quantity demanded for any positive price. With a second best option that is much inferior the agents on the long (demand) side of the market have to compete among themselves to make a trade. By contrast, those on the short (supply) side of the market are likely to have a second best option almost as attractive as their first, and that can translate to power to impose terms on their counterparties. When the power asymmetry is complete the *powerless* player would face a one-dimensional PD as what she does, defect or not, has no influence on the other player’s payoff.

Whenever private exchange entails an element of collective cost, as all complex transactions tend to do, the trading parties are incentivized to shift its burden onto the other - all the more so, the larger are the gaps in third-party enforcement. Broadly along the lines of *Coasian* bargaining over collective cost by traders in private exchange, this can be conceptualized as a PD game. In fact, in Flood’s (1952, 1958) original formulation of PD the focus is explicitly on the economy on (collective) transaction costs cooperation affords in the context of market exchange.<sup>3</sup> Traders can reap the potential mutual benefits of exchange in full when they cooperate, i.e., bear its collective costs equitably, which might however be unlikely under conditions of asymmetric power.

As well-known, players’ ability to punish defection by the other in repeated PD games changes their cost-benefit calculus and can give rise to cooperation. The player who starts out with cooperation makes herself vulnerable to receiving the *sucker* payoff lest the other player defects to secure the higher *temptation* payoff. In the event, retaliation by withholding cooperation in repeated encounters, if any, can cause both players to receive thereafter the inferior *punishment* payoff. Thus, in repeated games cooperation might emerge as the better option to opportunistic defection as its payoff can exceed over time the one-time *temptation* plus the reduced *punishment* return thereafter, provided that the future is not discounted *very* heavily.<sup>4</sup>

This outcome hinges on players ability to punish defection by the other. The players can successfully deter each other from defection if individually they perceive the other capable of retaliation in successive play. But, repeated encounters are not of much help if the withholding of cooperation by one player has (or perceived to have) little or no impact on the other’s payoff. The player who has little fear of being retaliated against can safely shift the burden of collective costs onto the other not only in their first initial encounter but perpetually since the other, *weak* player cannot by assumption punish defection. Provided that the weaker player’ second best option is even worse than the *sucker* payoff she might not choose to *walk away*. In repeated encounters cooperation would only emerge if the powerful player prefers it to unequal exchange, which in turn requires that the *reward* to cooperation is higher than the *temptation*

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<sup>3</sup> It might be remembered that his version of (PD) involves two friends transacting on an old used car and splitting the difference between the car dealer’s buying and selling price. For a history of (PD) in the literature, see Poundstone (1993, Chp. 6).

<sup>4</sup> There are also other ways in which cooperation can emerge, which are here ignored. For a broader discussion with an emphasis on group selection, see Nowak (2006) and Bowles (2013).

payoff. In what is to follow, I first reproduce briefly the condition for cooperation when power is symmetric under the so-called ‘grim trigger strategy’ and then show how it is altered under asymmetric power:

Consider the familiar payoff matrix for two players who are assumed to represent agents with symmetric power:

	Cooperate	Defect
Cooperate	$\lambda, \lambda$	$k, e$
Defect	$e, k$	$\theta, \theta$

Where first entry in each cell gives Row’s payoff and the second the Column’s, and where

- $\lambda$  – reward for cooperation
- $e$  – temptation payoff
- $k$  - suckers’ payoff
- $\theta$  – punishment payoff

When the game is repeated indefinitely, the return to cooperation is given by:

$$\lambda + \lambda\delta + \lambda\delta^2 + \lambda\delta^3 + \dots + \lambda\delta^n = \sum \lambda\delta^t = \frac{\lambda}{1-\delta}$$

where  $\delta$  is the discount factor that takes a value between 0 and 1, where a lower value implies that the future is discounted more heavily. For instance, a value of 0.9 would mean that the individual would be willing to take 90 cents on the dollar today rather than wait till the next period to receive the dollar, while .8 would mean she would accept 80 cents implying that the future values count for less.

When both players have the ability to punish defection by the other, the payoff of a player who defects against a non-defecting player who thereafter defects in retaliation (in, so-called, the *grim* strategy) is equal to:

$$e + \theta\delta + \theta\delta^2 + \theta\delta^3 + \dots + \theta\delta^n = e + \frac{\theta\delta}{(1-\delta)}$$

That means that the return to cooperation over time exceeds the payoff for defection when:

$$\lambda > e(1 - \delta) + \theta\delta \tag{1}$$

In other words, under symmetric power the likelihood of cooperation rises with the *reward to cooperation* and lower discounting of the future, and falls with the *temptation* and *punishment* payoffs.

Next, collective costs can be introduced to show how the condition for cooperation is altered under asymmetric power. Recall that in Flood’s version of the PD the source of the *reward* to cooperation is the economy on transaction costs (the cost of market making) borne by the car dealer. More generally, the higher *reward* to cooperation can result not only from the reduction in collective cost but also from the enhanced productivity of players. In other words, the Pareto improvement associated with cooperation

can have two separate sources; one, the economy on collective costs, and the other the increase in players' productivity caused by cooperation itself.<sup>5</sup>

The table below reproduces the above payoff matrix with collective costs:

	Cooperate	Defect
Cooperate	$\lambda - a\gamma, \lambda - a\gamma$	$k, e$
Defect	$e, k$	$\theta - \gamma, \theta - \gamma$

If players were to share collective costs equally their payoff would be lowered by  $\gamma$  in the absence of cooperation and by a smaller amount when they cooperate. That is, the *punishment* payoff would be lowered by  $\gamma$ , and the *reward* for cooperation by its fraction,  $a\gamma$ , where ( $0 < a < 1$ ), which gives the magnitude of collective costs cooperation cannot eradicate. Put differently, the portion of collective costs cooperation can eliminate is equal to  $(1 - a)\gamma$  per player.

The Pareto improvement from cooperation, denoted by  $m$ , is given by:

$$m = \lambda - a\gamma - (\theta - \gamma) = (\lambda - \theta) + (1 - a)\gamma = r + z$$

- i. the increment in private return,

$$r = \lambda - \theta > 0$$

and,

- ii. the economy on collective costs,

$$z = (1 - a)\gamma$$

Even though Pareto improvement is zero in the absence of cooperation, the powerful player (Column) might still be better off by shifting collective costs onto the powerless to the extent asymmetric power allows. In the limit when all collective costs are borne by the *weak* player, Row faces a one-dimensional PD since her defection has no influence on Column's payoff and the second row of the payoff matrix drops out. The *temptation* and *sucker* payoffs become, respectively:

$$\begin{aligned} e &= \theta \\ k &= \theta - 2\gamma \end{aligned}$$

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<sup>5</sup> An intuitive example can be a couple parenting a child. The overall cost of parenting is exogenously given, but when the parents cooperate not only these costs are less but also each parent's individual time with the child is more productive.



Cost shifting involves a zero-sum change - with a constant total sum of payoffs whatever the powerful player gains the powerless loses:

$$\theta - \gamma = (e + k)/2$$

We can also introduce a coefficient of asymmetric power ( $b$ ) in the respective payoffs,  $0 < b < 1$ . The total collective costs that are shifted on to the powerless player are then given by  $b\gamma$ , hereafter termed the level of “exploitation” and denoted by  $x (= b\gamma)$ . The level of exploitation is at its maximum when  $b$  is equal to unity and nonexistent when it is zero. The *temptation* and *sucker* payoffs take the form:

$$\begin{aligned} e &= \theta - (1 - b)\gamma = \varphi + x \\ k &= \theta - (1 + b)\gamma = \varphi - x \end{aligned}$$

where,  $\varphi = \theta - \gamma$ , and the first row of the above payoff matrix can also be written equivalently as:

$$(\varphi + m), (\varphi + m) \qquad (\varphi - x), (\varphi + x)$$

Provided that unequal exchange remains viable (see next section), the powerful player will not prefer cooperation unless its return exceeds the *temptation* payoff, i.e.,

$$m > x \qquad \text{or} \qquad r > x - z.$$

In other words, cooperation to be viable will require an increment in the powerful player’s private return that is higher than the difference of the level of exploitation and the economy on collective costs cooperation affords. This means that, all else being the same, the greater the level of asymmetric power, the lower is the likelihood of cooperation. Likewise a lowered ability to reduce collective costs can reduce the attractiveness of cooperation for the powerful player even though it might still be privately beneficial.

It is plausible that the three variables, asymmetric power, effectiveness of cooperation in reducing collective costs and its incremental impact on private return, might interact. Especially,  $z$  might be negatively related to the level of asymmetric power,  $b$ , given that parties’ level of contention, the higher one would expect the greater the power asymmetry, can reduce cooperation’s effectiveness in reducing collective costs. Past a certain threshold, this negative relationship might get stronger over time to the extent it entrenches a culture of conflict which agents begin to take as a given in their decision making process, rendering cooperation less effective over time. With the aid of a graph this can perhaps be expressed more clearly. Setting  $\gamma$  equal to unity and re-writing the condition for cooperation:

$$b + a < 1 + r$$

In Figure 1, any combination of values of  $a$  and  $b$  inside the triangle satisfies the condition for cooperation, and the ray from the origin depicts  $a$  as a positive function of  $b$ . To the extent this negative relationship tends to get stronger over time for *higher* values of  $b$ , policies that target  $\theta$  that end up increasing asymmetric power need not jeopardize cooperation initially, but nonetheless do so over time – i.e., with the steepening of  $f(b)$  the sum of  $a$  and  $b$  might fall outside the triangle that bounds the solution set for the condition of cooperation. The prospect for cooperation would also depend on whether  $r$  rises or falls, which could be shown by shifting the outer boundary of the triangle in Fig 1 up or down.

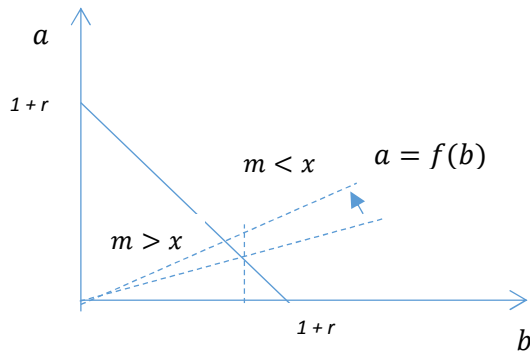


Figure 1

## II. Why do not wages fall to zero?

If no positive market clearing wage exists because of oversupply the question is what prevents wages from falling down to zero? Most *efficiency wage* arguments contend that *enforcement rents* are resistant to market pressure from unemployed workers because their claims that they can do as good a job as the employed for less are not credible. If an efficiency rent is needed to keep workers from shirking, the unemployed workers once employed for less would also shirk and thus require a higher wage not to. Thus, the level of the enforcement rent is determined competitively by the maximizing decisions of employers to reduce shirking or labor turnover (Yellen 1985, Akerlof & Yellen 1990). While shirking might be more relevant in the case of skilled workers with high monitoring costs, with low-skill workers labor turnover is likely to matter more. This section extends the PD game introduced above showing that workers' ability to *walk away* and engage in on the job resistance, on the one hand, and the cost of job termination to the employer on the other can put a floor below which it is not profitable for employers to try to drive down workers' pay. Even though the powerful has the power to *exploit*, the powerless still has at least some control over her job performance and the duration of employment. As in any unequal relationship the party that is getting the short end of the stick is incentivized to look harder for a better alternative, and is expected to terminate trading as soon as a better opportunity is found.<sup>6</sup>

Three changes are made in the *temptation* and *sucker* payoffs, which here take the form:

$$e(t) = \varphi t + c[x, t(x)]xt \quad \text{- the temptation payoff}$$

$$k(t) = (\varphi - x)t - s(t) \quad \text{- the sucker payoff}$$

First change accounts for the variable length of employment, or trading time  $t$ , which is defined as the number of times the game is played. In the absence of cost shifting both players draw a benefit equal to  $\varphi = \theta - \gamma$  per play as assumed above, and  $\varphi t$  over the length of their encounter (period of

<sup>6</sup> The *enforcement rent* thus determined might not however cover the 'living wage'. Though important this possibility will have to be pursued in another paper.

employment); and, when power is asymmetric,  $x$  is again the level of exploitation corresponding to the costs shifted in one play, and thus  $xt$  is the total costs shifted over the length of trading.

The second change introduces the idea that the level of exploitation might be constrained by workers' ability to resist or *walk away*, and how costly that is to employers. It is now assumed that cost shifting is *negative-sum*. The powerful player's gain from cost shifting might be less than the powerless player's loss. This amount is given by  $cxt$ , where  $c$  is the benefit the powerful player draws per unit cost shifted onto the powerless. In other words, the coefficient  $c$  captures to the ability of the powerful player to exploit the weakness of the *weak*, which is assumed to be an increasing function of length of trading  $t$ , ( $c_t > 0$ ), and a decreasing function of the level of exploitation because workers tend to *walk away* sooner,  $t_x < 0$ , and increase their on the job resistance ( $c_x < 0$ ) when the level of exploitation is higher. Thus, an increase in the level of exploitation need not result in a proportional increase in the *temptation* payoff to the extent the average length of employment is reduced and workers become recalcitrant. The cost of a lower length of employment (i.e., higher labor turnover) to the employer in turn depends on technology and its commensurate labor process. For instance, as discussed in detail in the next section,  $c_t$  is likely to be high in craft or artisan production compared to what it would be under mass production. Given these assumptions, the marginal benefit from increased exploitation diminishes at higher levels of exploitation and vanishes at some maximum level. The *powerful* player can be assumed to choose the level of exploitation that maximizes her payoff, satisfying the condition,  $\frac{de}{dx} = 0$ , which gives:

$$c_{max} = -(c_x + c_t t_x)x$$

where  $c_{max}$  is equal to unity or some exogenously given constant that defines the maximum benefit the powerful player can draw per unit cost shifted onto the powerless.

Figure 2 depicts the 'optimal' level of exploitation for some arbitrary set of values for  $c_x$  and  $c_t$ , and  $t_x$ . The first two coefficients are assumed exogenously given, while  $t_x$  is derived from the maximizing decisions of workers, discussed next.<sup>7</sup>

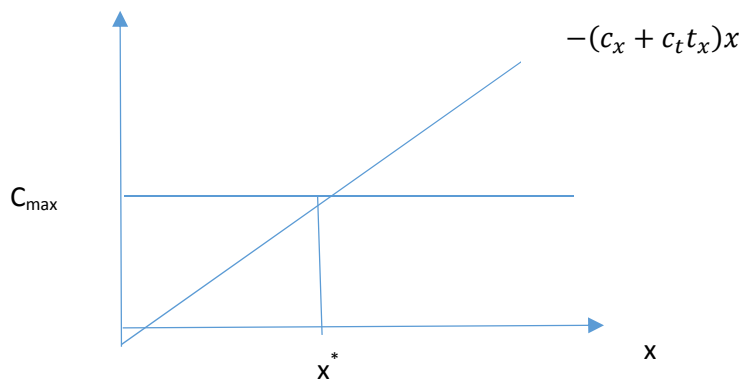


Figure 2

The third change involves modeling workers' ability to *walk away* by introducing an opportunity cost of employment function in the *sucker* payoff. Economists think axiomatically (and arguably tautologically) that when someone walks away from a job it is because the marginal cost of staying on the job exceeds its marginal benefit when termination occurs. This also suggests that before the worker quit her marginal

<sup>7</sup> A linear relationship is assumed for simplicity.

cost of employment remained lower than the marginal benefit she drew from the job, with the implication that during the period she was employed the former had been rising faster than the latter. The simplest way to model this would be to assume that employment's marginal opportunity cost is a monotonically increasing function of time,  $s'(t) > 0$ , and it becomes equal to the marginal benefit of staying on the job at the point of job termination.

All else being the same, a higher level of exploitation reduces the marginal benefit of employment, pushing down  $\varphi - x$ , reducing the length of time the representative worker wants to stay on the job. Figure 2a depicts what happens to the duration of employment when the level of exploitation increases from  $x_0$  to  $x_1$ , while Figure 2b gives the  $\frac{dk}{dt} = 0$  isocline in the  $t - x$  space that is derived from it. The slope of  $t_x$  in Figure 1 is thus given by the slope of this isocline.

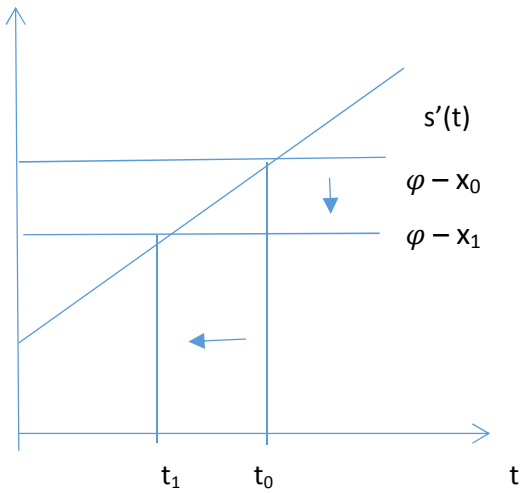


Figure 2a

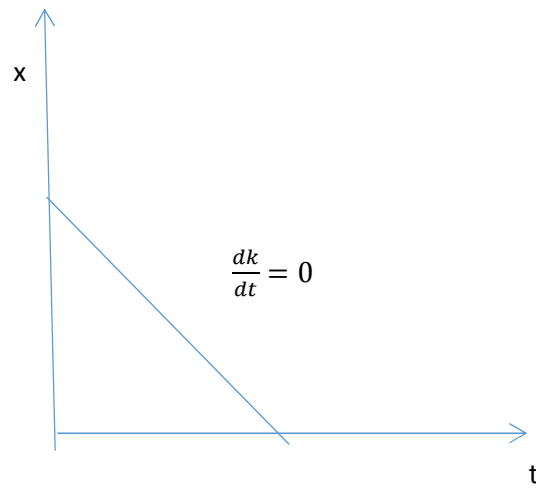


Figure 2b

Putting these diagrams together it is relatively straight forward to see how the oversupply of labor brought about by secular changes in market conditions of the type experienced in recent decades can lower workers' ability to walk away from a job, resulting in a lower payoff for labor. When jobs are harder to find, the marginal cost of employment rises more slowly than before, causing the  $s'(t)$  schedule to tilt down (Graph 3a) flattening the  $\frac{dk}{dt} = 0$  isocline (3b). It follows that for a given increase in the level of exploitation the fall in the length of employment is now less ( $t_x \downarrow$ ). Moreover, to the extent worsening labor market conditions also lowers workers' power to organize, their on the job resistance might also decrease ( $c_x \downarrow$ ), while changes in technology can make labor turnover less costly to employers ( $c_t \downarrow$ ). The combined effect of all of these forces would be to tilt down the *effective exploitation* line,  $-(c_x + c_t t_x)x$ , in Figure 3c, making exploitation possible at a higher level.

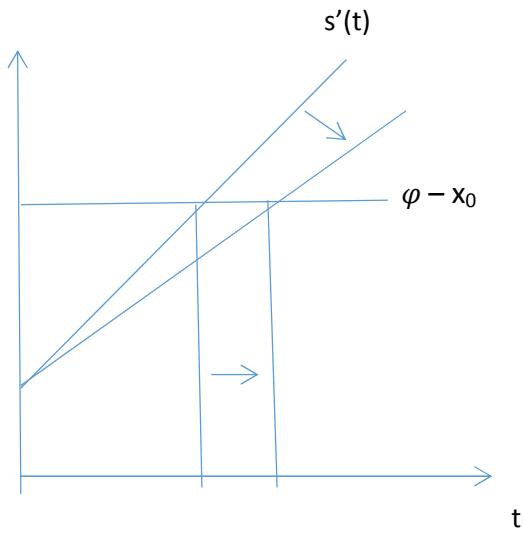


Figure 3a

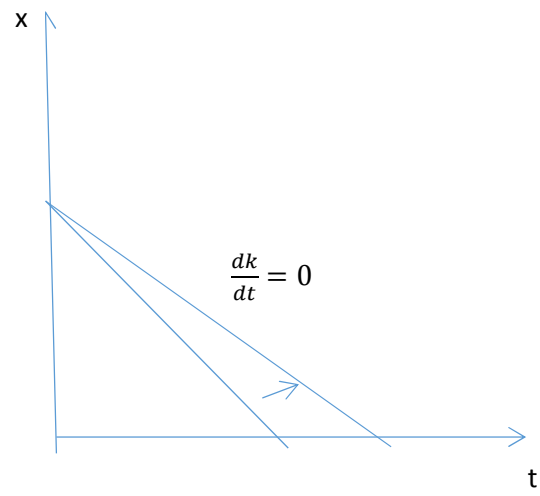


Figure 3b

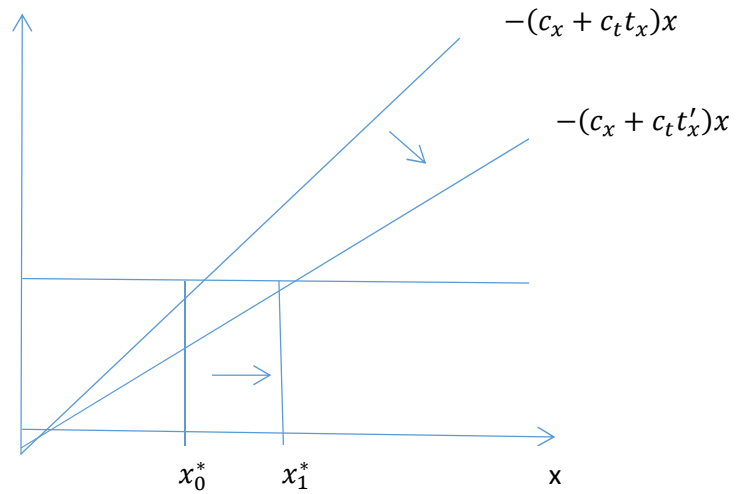


Figure 3c

### III. Skill Replacing Technological Change and Organization of Work

The nature of technology and its commensurate labor process determine how costly labor turnover is for employers. For instance, when organization of work consists mainly of non-routine tasks performed by skilled craftsmen using non-standard technology, job termination is likely to be relatively costly because

the cost of both finding new workers and training them will be high. By contrast, if work involves mainly a series of routine tasks that can be performed by low skill workers with the aid of standardized technology that is easy to operate, replacement and pre-training costs following job termination will be low. The question then becomes how does technological change affect the organization of work and whether it enhances workers' skills, such that those performing complex, non-routine tasks become more productive, or replace them making the skilled workers redundant? All else being the same, when skill-enhancing, technological change raises the relative value of workers to their employers, lowers the level of exploitation and push wages higher, and *vice versa*.

But, the causation can run the other way too. Changes in labor market conditions and power asymmetry between capital and labor can incentivize capitalists to transform how work is organized, which in turn increases the demand for innovations that make that possible. While there is no reason to assume why both modalities of technological change (skill enhancing as well replacing) would cease to coexist, one type of technological change can predominate over the other in a given era while the other type in another. The 19<sup>th</sup> century capitalism, characterized by conditions of excess labor, is a case in point. The weakening of pre-capitalist property claims on workers and restrictions on their mobility resulted in the flow of workers into towns from the countryside in search of employment, giving rise to the lopsided labor markets that was an important characteristic of capitalism during this period. As Marx tried to analyze in some detail, the conditions of unlimited supply of labor that resulted appears to have incentivized capitalists to transform the labor process to overcome their dependence on skilled craftsmen whose relatively inelastic supply posed a potential bottleneck.

The craft organization of labor lent itself well to the production of non-standard and customized goods as it could flexibly adjust to changes in demand and shifts in relative prices. Workers took a long time to acquire the prerequisite level of skills, but once they did they also gained an ability to flexibly assign their skills to a multiplicity of tasks that often varied from one job to another and apply them to new ones as required. The labor exchange was relatively equal as capitalists faced competition among themselves for these skilled craftsmen. That meant power symmetric labor exchange (as defined in Section I above) as each side's ability to adversely influence the other's payoff was not drastically dissimilar (Figure 4a).<sup>8</sup> Given the nature of the labor process and high monitoring costs, mutual cooperation was in the interest of both the worker and the employer. Since both sides had the power to adversely affect the other's payoff, in a repeated game context there was potential for cooperation to emerge.

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<sup>8</sup> A bigger number indicates a higher payoff.

## Capitalists

		Capitalists	
		Cooperate	Defect
Skilled Workers	C	3,3	1,4
	D	4,1	2,2

Figure 4a: Labor Exchange with Skilled Craftsman

The relative inelasticity of the supply of high-skill workers, however, was a serious drawback for capitalists. Given the complexity of the required skills and the time it took to acquire them, any sustained increase in demand for labor when growth picked up risked rapidly rising wages and thus a squeeze on profits. Output expansion was self-constrained in yet another important way. Expanding employment involved significant diminishing returns because the organization of work depended on a crew of workers whose individual tasks were coordinated by a master craftsman. Thus, adding on new workers involved significant adjustment costs, and effective coordination began to suffer and average costs increased once an optimal crew and firm size was exceeded.

These drawbacks appear to have created incentives to switch to producing standardized goods which were cheaper, though often inferior, substitutes for custom crafted goods. The cost advantage was achieved by scale economies made possible by breaking down each complex task performed by skilled workers to a series of routine tasks that could be performed by low skill workers (Sokoloff 1984). This also paved the way for the introduction of machinery since an organic arm could be replaced by a mechanical one relatively easily when it performed a simple, routine task. The relationship between skills and tasks, fluid and complex in the craft system, was thereby transformed into a rigid pairing of low level skills with a fixed number of routine tasks. Once the organizing principle and unifying thread of production became a fixed set of well-defined routine tasks, the need for skilled craftsmen dissipated. The inelastic supply of skilled workers and the inflexible crew size ceased to be constraints on production with the progressive transformation of the labor process that eventually culminated in the rise of *mass production* and the modern *assembly line*.<sup>9</sup>

This was in a nutshell Marx's account of skill replacing technological change. In his view, reorganization of work was a prelude and often the precondition of mechanizing production. At least initially, its very objective was to make the substitution of (abundant) unskilled workers for (scarce) skilled workers possible. The relative ease with which the average worker could be dispensed with altered the nature of labor exchange as asymmetric power imprisoned her in a one-dimensional PD (Figure 4b). That in turn could raise the level of exploitation (as depicted in Figure 3c), for reasons stylistically emanating from: (i) the reduction in employers' vulnerability to labor turnover ( $c_t$ ) given the reduced pre-training costs of

<sup>9</sup> Edward J. Nell characterizes the craft production as a 'fixed employment – variable productivity' system, and standardized or mass production economy one that is defined by 'fixed productivity and variable employment' given that employment can be increased without a fall in productivity. See Nell (2005), for an extended discussion of the craft production and its affinity to the type of economy the traditional neoclassical model depicts.

workers; and, (ii) the fall in workers' ability to engage in on the job resistance ( $c_x$ ) because of the increased competition from the unemployed workers.

### Capitalists


		Cooperate	Defect
Unskilled Workers	C	3,3 	1,4
	D	4,1	2,2

Figure 4b: Labor Exchange with Unskilled Workers

However, the overall process was not one of *de-skilling* alone. As Golding and Katz (1998) point out the rise of *mass production* also had the effect of raising the demand for a new breed of skilled workers such as engineers, designers and managers who were the latter-day craftsmen.<sup>10</sup> The overall picture is rather one of bifurcation of jobs and their organization of labor, with technological change having disparate effects on skills in each case. Whenever the goods and services produced are non-standard it is a safe generalization to say that the organization of work tends to remain along *craft* lines. These are often the 'good' jobs, where high-skill workers perform non-routine tasks using non-standard technology.<sup>11</sup> With an equal and cooperative labor exchange, this is also the world of high monitoring costs, Y-management and efficiency wages. It contrasts rather starkly with the way standardized goods and services are produced by low-skill workers who perform easy to monitor routine tasks. Despite their decreasing numbers, these workers continue to occupy an important part of the secondary sector jobs.<sup>12</sup>

The nature of technology and the effect technological change has on skills is also very different in both cases. In (routine) secondary sector jobs, a machine used in production is designed with a view to

<sup>10</sup> In part to emphasize the explosive growth of the *mass production* economy and the rise of mega companies at the turn of the 20<sup>th</sup> century, some writers seem to have argued that the craft system was replaced by standardized methods of production (or mass production) once for all (Braverman 1974; Marglin 1974; Aglietta 1979). However, as Piori and Sable (1984) remark, even at the height of so-called *Fordism*, the product specific, dedicated machinery that comprised the backbone of *assembly line* production had to be produced by skilled *craftsmen* for the simple reason that it itself could not be produced by standardized techniques *en masse* given its specialized nature. Also, see Adler (1990) who among others takes issue with the view that Marx considered only skill replacing technological change.

<sup>11</sup> There was a time when skill differences between primary and secondary sector workers did not seem to matter (Bulow & Summers 1985) With the 1990s job polarization the nature of labor market segmentation appears to have been altered as well.

<sup>12</sup> Their ratio to other secondary sector workers who perform manual non-routine tasks such as personal services has been steadily decreasing within the last couple of decades. For the purposes of the discussion here when I use the term 'secondary sector' I will be referring to the former group only.



minimize workers' pre-training costs. It thus tends to be product-specific and single-purpose so that low skill workers can operate it easily. It is not unusual for better machines to replace older machines in succession so that they can be operated by fewer and fewer operators with even lower skills. By contrast, a machine used by the skilled primary sector workers is one that is designed for flexible use in performing an ever changing multitude of non-routine tasks that varies from job to job. It will thus tend to be multi-purpose, requiring specialized knowledge and skills to use (Nell 2005). Thus, technological change (at least when it is embodied in a new machine) will tend to enhance worker skills in primary sector jobs, while downgrading and replacing them in standardized jobs.<sup>13</sup> At the same time, however, labor market conditions can also incentivize search for innovations that enable the transformation of non-routine tasks into a subset of routine ones, which can then be offshored to low skill workers and eventually automated. Thus, induced changes in technology can be skill replacing in primary sector jobs as well.

This line of analysis can provide a novel way of looking at the technology – skill nexus, which might be helpful in understanding recent labor market trends, especially the increasing paucity of good jobs. In the standard analysis, labor market conditions affect the choice of technique through their influence on the relative factor prices, but what goes into the menu of techniques available for adoption (and their level of productivity) is solely the domain of technology. The same appears to be true for the menu of routine and non-routine tasks at a given point in time as well. For instance, during the 1990s 'job polarization', the demand for mid-skill jobs was decreasing despite falling wages, which suggested strong technological displacement. Introducing a separation between skills and tasks, Acemoglu and Autor (2011, 2012) argued that job polarization was the result of technological change replacing routine tasks while leaving non-routine tasks, both low and high skill, relatively untouched. In their view, technological change could still be broadly skill enhancing, while replacing skills only to the extent they were rigidly tied to the displaced routine tasks. In their analysis, it was an "accident" of technology why some skills were rigidly tied to routine tasks while others were not. The menu of routine and non-routine tasks was assumed exogenously given by autonomous technological change.

#### IV. Labor Market Conditions and the Effect of Technological Change on Skills

While it is true that technological innovations determine what non-routine task can at all be transformed into routine ones, the attractiveness of doing so is not independent of labor market conditions. The relative abundance of cheap labor incentivizes searching for innovations that make it possible chipping away whatever component can be routinized from complex tasks that are performed by expensive skilled workers. As Krugman (2011) remarks while "robot janitors are a long way off; computerized legal research and computer-aided medical diagnosis are already here." Technological change does not blindly target all non-routine tasks but mainly those performed by skilled labor when it is relatively expensive.

The negative effect of cheap labor on 'good' jobs can be captured by a simple n-person extension of the game from Section I. Keeping in mind our discussion in Section III, assume an economy where *craft* and *standardized* methods coexist, producing respectively goods that are imperfect substitutes.<sup>14</sup> Individual capitalists have to decide between the two methods, employing either high skill craftsmen or unskilled workers who work with standardized technology. The return on skilled workers is higher but diminishes with higher employment because of their inelastic supply and craft organization, whereas the return to

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<sup>13</sup> Also, investing in human capital poses a problem because improvements in workers' skills are unlikely to be firm-specific. Skill replacing machinery also has the advantage of solving this problem. Acemoglu & Pischke (1998) argue that information asymmetries might explain why firms invest in human capital at all.

<sup>14</sup> Further assume for simplicity that in each method no possibility of substitution exists between capital and labor, or between different skill grades of labor.

unskilled workers, though lower, remains constant. Despite their lower productivity, low-skill workers' supply is perfectly elastic and their productivity does not diminish with employment given the standardized technology they work with.

With  $n$  capitalists who have already employed skilled workers, the  $n + 1^{st}$  capitalist makes a decision between employing skilled or unskilled workers by comparing their respective return:  $P(n + 1)$  for skilled workers, and  $S(n)$  for unskilled workers:

$$P(n + 1) = \varphi + m(n)$$

$$S(n) = \varphi + x$$

The difference between the two payoffs can be conceptualized as the difference between positive sum labor exchange that is power symmetric and one that is power asymmetric and zero-sum. As can be recalled from Section I, this difference is equal to:  $m = r + z$ , and cooperation is preferred by the powerful when:  $m > x$ . Thus,  $P(n + 1) > S(n)$  - the positive sum nature of the labor exchange and the higher productivity of skilled workers secures a payoff better than the return of low skill workers - when  $m(n) > x$ .

The return on skilled workers diminishes at the rate  $m_n$  with more capitalists employing them:

$$m(n) = z - m_n n$$

The point where  $P(n + 1)$  and  $S(n)$  intersects the advantage of positive-sum labor exchange dissipates relative to *exploitation*,  $m(n) = x$ , and yields a stable Nash equilibrium (Figure 5a). When the number of capitalists who hire skilled workers exceed  $n^*$  the return on them falls below the return on unskilled workers. As some capitalists switch from craft production to hiring unskilled workers the respective returns are equalized. Likewise, when the number of capitalists who hire skilled workers is less than  $n^*$  the return to craft production is higher, and when that attracts other employers the return is lowered into equality with the return on unskilled workers.

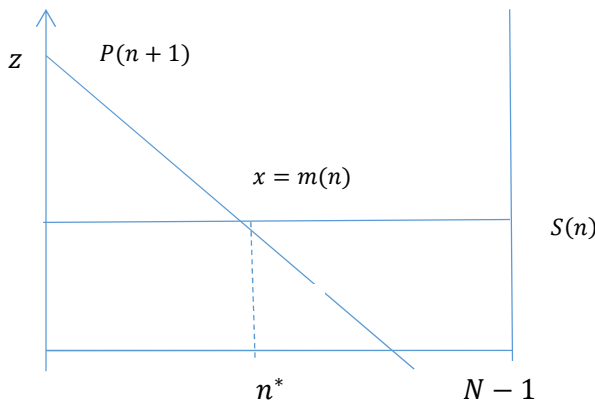


Figure 5a

The relative size of craft production (and demand for skilled workers) is thus given by:

$$n^* = \frac{z - x}{m_n}$$

showing that at equilibrium (with a given  $z$  and  $m_n$ ) the level of exploitation and employment of skilled workers are inversely related. An increase in the level of exploitation for any of the reasons discussed in Section II (Figure 3c), reduces the relative attractiveness of craft production and thus the employment of skilled workers at the new equilibrium, all else being the same.

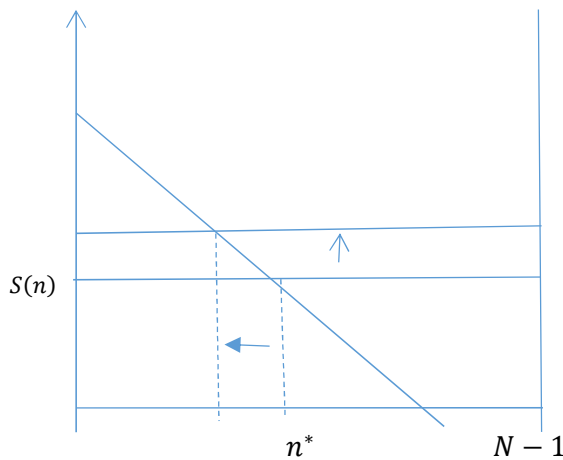


Figure 5b

The higher level of exploitation can also reduce the employment of skilled workers indirectly in two other ways: on the one hand, by lowering the potential effectiveness of cooperation in eradicating collective costs ( $z$ ) as higher power asymmetry raises the level of contention and enforcement costs, (i.e., giving rise to a higher  $a$  in Figure 1 above), and, on the other, by reducing  $m_n$  to the extent the shrinking size of craft production generates negative network effects and skill mismatches that cause its return to diminish faster.

It is possible that over the longer run the new equilibrium might not be stationary. The very distributional shift towards profits associated with the higher level of exploitation can stimulate economic growth which can eventually soak up the cheap excess labor. This is what Marx considers when he argues that economic growth can reduce the size of the *reserve army of labor*, causing wages eventually to rise.<sup>15</sup> Rising demand for labor makes the process depicted in Figures 3(a-c) work in reverse. With the aid of higher employment workers acquire the power to influence the payoff of capitalists through power-balancing collective action. The nature of labor exchange gets transformed and the average worker ceases to be

<sup>15</sup> When the rise in wages overshoots and depresses profits, it checks growth lowering the demand for labor. The reserve army of labor increases again, giving rise to a cycle that repeats itself. Goodwin's (1967) eloquent formulation of Marx's argument has since spawned a voluminous literature which generally ignores how organization of work is transformed in the process.

locked in a one-dimensional PD (Figure 4c). This would cause the return on unskilled workers,  $S(n)$ , to shift down in Figure 5b, expanding the size of craft employment in the new equilibrium.

		Capitalists	
		Cooperate	Defect
Industrial Workers	C	3,3	1,4
	D	4,1	2,2

Figure 4c: Labor Exchange with Organized Labor

A simple way to capture this potential growth effect would be by making  $N$  a function of  $x$ . A higher level of exploitation can then be shown to have three disparate effects:

The capitalists' total payoff ( $T$ ) at equilibrium is equal to:

$$T = n^*(m - x) + N(\varphi + x)$$

and, its change with respect to  $x$  is given by:

$$T_x = [n_x^*(m - x) + n^*(m - x)_x] + N_x(\varphi + x) + N(\varphi + x)_x$$

which comprises three parts:

$$\begin{aligned} \Delta A &= n_x^*(m - x) + n^*(m - x)_x \\ \Delta B &= N(\varphi + x)_x \\ \Delta C &= N_x(\varphi + x) \end{aligned}$$

Figure 5c depicts these effects when exploitation is rising. The first ( $\Delta A$ ) shows the reduced income (employment) of skilled craft workers, the second ( $\Delta B$ ) gives the transfer of income from unskilled workers to capitalists; and, the third ( $\Delta C$ ) shows the increased employment of unskilled workers.<sup>16</sup>

<sup>16</sup> For workers the payoff calculus is however different. While the loss in primary markets ( $\Delta A$ ) is symmetrical, capitalists' gain is equal to their loss in  $\Delta B$ , and workers' gain falls short of capitalists' in  $\Delta C$  the higher the value of  $x$ .

$$\begin{aligned} \Delta A_w &= n_x^*(m - x) + n^*(m - x)_x \\ \Delta B_w &= -N\Delta x \\ \Delta C_w &= \Delta N(\varphi - x) \end{aligned}$$

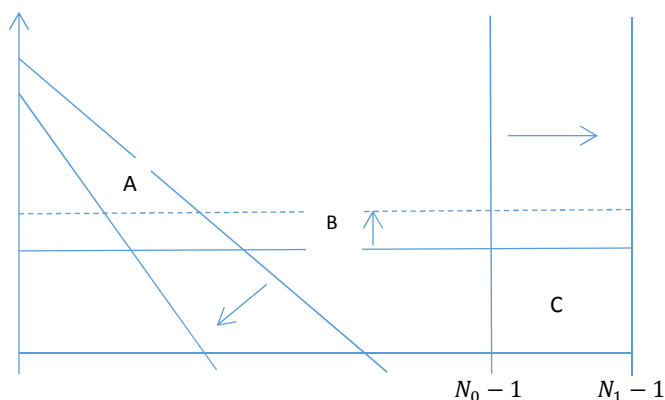


Figure 5c

When the growth effect of higher profitability, depicted by  $\Delta C$ , transforms the nature of the labor exchange, the process depicted in Figure 5c works in reverse, making power-balancing by workers easier. As power-symmetry is restored, the employment of skilled workers ( $\Delta A$ ) begins to expand and the growth dynamic is spearheaded by improvements in human capital where skill augmenting effects of technological change can predominate. The positive sum nature of the capital labor interaction and the higher labor productivity can obviate (at least for a time) the potential squeeze on profits. The observed skill enhancing pattern of technological change during much of the 20<sup>th</sup> century US might in fact be explained by sustained high economic growth that kept the overall demand for labor strong, maintaining a relative symmetry of power between capital and labor.

### Conclusion

The long post war growth upswing in advanced capitalist economies had an important institutional dimension. With power balancing, workers successfully sought institutional labor market barriers (within their respective nation-states) restricting competition from unemployed workers *elsewhere* to safeguard against an easy slide into lopsided labor markets at the first sign of slack demand. While many of the political barriers that restrict labor mobility by and large remain intact, global integration of markets (and production) has made it increasingly difficult for low skill workers in advanced countries to shield themselves from competition from *elsewhere*. Globalization can in fact be thought of as a backlash that has circumvented and partially dismantled these barriers. Yet, it also appears to have robbed the system of its built-in mechanism to correct lopsided labor markets. While the offshoring of standardized jobs has gone up the skill ladder faster than anyone had ever anticipated, all new employment expansion ( $\Delta C$  in Figure 5c) has been taking place mainly *elsewhere*. In the meantime, high value added employment in advanced countries appears to have stagnated, if not begun to shrink, even long before the financial crisis. Until recently it was a widely believed that in advanced economies globalization and technological change, while harmful for those working with their hands, benefit those working with their minds. It is highly doubtful that the second part of this proposition holds true any longer. Nor is it true that better education was the panacea in this new economy. This is caused not so much by a blind fate autonomous nature of technological change has imposed on us as by the large power asymmetry that has developed between capital and labor in the last few decades.

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