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NO ONE IS ALONE: STRATEGIC COMPLEMENTARITIES, CAPACITY UTILIZATION, GROWTH, AND DISTRIBUTION

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ABSTRACT

A longstanding criticism to Keynesian and Kaleckian growth theories is the question: why would firms operating with underutilized capacity still accumulate capital stock? This paper offers an answer by analyzing the choice of capacity utilization and accumulation in a strategic setting. The argument hinges on the Keynesian notion of user cost of capital. We argue that firms have incentives to wait to see what other firms are doing before adjusting their own utilization, which we capture through a marginal user cost of own utilization decreasing in average utilization. Accordingly, interactions among firms involve strategic complementarities: it is profit-maximizing to increase own utilization with average utilization. Since the latter is a reasonable proxy for demand, (i) the analysis provides a rationale for treating desired utilization as endogenous to demand at the firm level. In general equilibrium: (ii) capital accumulation coexists with underutilization; (iii) if firms were able to coordinate on a common utilization rate, utilization would be strictly higher than in equilibrium. The implications for growth and distribution depend on how the model is closed: (iv) with a distributive closure, equilibrium growth and profitability are both strictly below their socially-coordinated counterpart; (v) with an exogenous labor supply closure, the equilibrium labor share is strictly smaller than under coordination. Hence, (vi) there are mutually beneficial bargaining opportunities for both capital and labor. Moreover, (vii) demand policies have multiplier effects. The slow recovery from the Great Recession in the US provides a prime example of the relevance of equilibrium underutilization. Finally, we use state-by-sector data from the BEA to validate our hypothesis: (viii) our estimation results provide strong and robust support for the relevance of strategic complementarities in the US.

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No One is Alone: Strategic Complementarities, Capacity Utilization, Growth, and Distribution

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April 8, 2018

Abstract

A longstanding criticism to Keynesian and Kaleckian growth theories is the question: why would firms operating with underutilized capacity still accumulate capital stock? This paper offers an answer by analyzing the choice of capacity utilization and accumulation in a strategic setting. The argument hinges on the Keynesian notion of *user cost* of capital. We argue that firms have incentives to wait to see what other firms are doing before adjusting their own utilization, which we capture through a marginal user cost of own utilization decreasing in average utilization. Accordingly, interactions among firms involve strategic complementarities: it is profit-maximizing to increase own utilization with average utilization. Since the latter is a reasonable proxy for demand, (i) the analysis provides a rationale for treating desired utilization as endogenous to demand at the firm level. In general equilibrium: (ii) capital accumulation coexists with underutilization; (iii) if firms were able to coordinate on a common utilization rate, utilization would be strictly higher than in equilibrium. The implications for growth and distribution depend on how the model is closed: (iv) with a distributive closure, equilibrium growth and profitability are both strictly below their socially-coordinated counterpart; (v) with an exogenous labor supply closure, the equilibrium labor share is strictly smaller than under coordination. Hence, (vi) there are mutually beneficial bargaining opportunities for both capital and labor. Moreover, (vii) demand policies have multiplier effects. The slow recovery from the Great Recession in the US provides a prime example of the relevance of equilibrium underutilization. Finally, we use state-by-sector data from the BEA to validate our hypothesis: (viii) our estimation results provide strong and robust support for the relevance of strategic complementarities in the US.

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You decide, but / You are not alone
Believe me / No one is alone
(From *Into the Woods*, by Stephen Sondheim)

1 Introduction: the 'Utilization Controversy'

The relationship between aggregate demand and the functional distribution of income is of central importance in post-Keynesian economics. In Kaleckian growth models, the role of aggregate demand is usually proxied by the rate of utilization of installed capacity. If an economy has underutilized capacity—as it will typically be the case when effective demand is relevant—then a whole set of policy implications that are paradoxical from both Classical and Neoclassical standpoints will hold true. First, the Keynesian paradox of thrift will apply, according to which a reduction in savings and an increase in consumption will generate a boost in aggregate demand. Second, the paradox of costs might hold, in that a redistribution toward wage-earners and away from profit-earners will also foster aggregate demand (Rowthorn, 1982; Dutt, 1984). Third, an increase in the state of confidence of the economy—be that investors' animal spirits or consumer confidence—will be self-sustaining and matched by an increase in the level of economic activity: a Keynesian version of the biblical metaphor of the widow's cruse, that keeps on filling even as water is constantly drawn away from it.

One of the main criticisms drawn to the Kaleckian enterprise as a plausible theory of long-run economic growth is that it is not clear why firms should keep accumulating capital stock even in the presence of spare capacity. Such criticism has a strong logical bite to it and has been hard to dismiss for post-Keynesians because it is coming from economists working within alternative traditions, more than from Neoclassical researchers. Kaldorian and Harrodian economists (Auerbach and Skott, 1988; Skott, 1989, 2010, 2012) are unconvinced by an ever-adjusting normal rate of utilization because such behavior is incompatible with long-run equilibrium. Authors in the Classical tradition (Kurz, 1986; Duménil and Lévy, 1999; Foley and Michl, 1999, Chapter 10) have also argued that, even though demand considerations are important in the short run, Say's law must eventually prevail in the long run: accordingly, the long-run (also referred to as normal or desired) rate of utilization should be set independently of aggregate demand. Similar conclusions are reached by Shaikh (2009). In general, what comes into question is the endogeneity of the long-run rate of utilization to aggregate demand. If such endogeneity vanishes as the economy adjusts to its long-run position, the Keynesian paradoxes will be confined to short-run phenomena (Duménil and Lévy, 1999).[1]

The Kaleckian response has come on two grounds. A first line of defense consists in arguing that the normal rate of utilization is a 'moving target influenced by its past values' (Lavoie, 1996; Dutt, 1997): an adjusting variable even in the long run, in other words. In an important paper, Nikiforos (2015) has

[1]Versions of the Keynesian paradoxes might hold in Kaldorian models and models with Harrodian instability. See Skott (1989).

both criticized this response and offered an alternative argument to rescue the Kaleckian endogenous utilization. The *pars destruens* of the argument is that utilization '[...] is one of the most important decisions for a firm, analogous to the choice of technique. It is hard to see why an entrepreneur will treat a decision of such importance for the profitability and the survival of its firm merely as a convention.' The *pars construens* of the argument is based on a critique of the notion of utilization provided by the Federal Reserve, which is constructed to be stationary. An alternative definition would be to take the ratio of the actual workweek of capital over the engineering capacity of 24*7 = 168 hours at the highest speed of operation. According to this definition, Nikiforos (2015) reports evidence of endogenous adjustments of the desired rate of utilization as the economy grows. He then develops a partial equilibrium model in which the extent of increasing returns determines the magnitude of the adjustment in utilization following an increase in the demand for the firm's product. For completeness, one should also report the Neoclassical argument by Spence (1977), according to which firms operating in non-competitive conditions will in general choose to underutilize their plants in order to create scarcity for their product and deter entry in their market.

Both the post-Keynesian and Neoclassical arguments for an endogenous long-run utilization rate do not question the fact that firms act in isolation when choosing about how much to utilize their plants. Lavoie's argument requires firms to use information about their own utilization's past values; Nikiforos' argument requires firms to use information about the extent of increasing returns to their own installed capacity; Spence's argument requires firms to know the price-elasticity of their own demand curve. None of these arguments considers the role of choices made by other firms. Moreover, both Spence and Nikiforos consider partial equilibrium frameworks, in which either the size of capital stock is fixed or the extent of increasing returns is purely external to the firm.

But what if firms are not, in fact, isolated from one another? What if other firms' utilization choices could be used as a signal by a firm in order to select how much to utilize its own plants? Such considerations are the starting point of this paper. The main argument is that individual firms, when making decisions about utilization, consider the choices made by other firms in order to proxy for (or validate their own expectations about) expected demand: a synthetic signal for other firms' behavior is the average rate of utilization, be that in a specific sector or in the whole economy in the 'representative' firm case. We build a simple model that hinges on the Keynesian notion of *user cost* of capital, that is the loss in the value of installed capital stock because of its use. In the words of Keynes,

> User cost constitutes the link between the present and the future. For in deciding the scale of production an entrepreneur has to exercise a choice between using up his equipment now or preserving it to be used later on [...] (Keynes, 1936, pp. 69-70.).

Greenwood *et al.* (1988) formalized the user cost through a strictly convex depreciation function in an otherwise off-the-shelf Real Business Cycle model to argue about the importance of capacity utilization in explaining macroeconomic fluctuations. Their modeling argument is that an increase in utilization stimulates the accumulation of new capital but accelerates the depreciation of existing capital stock, so that depreciation is strictly convex—as opposed to linear—in the utilization rate. As we will show below, however, this individual user cost motive alone is not enough to generate a dependence of utilization on its average counterpart (or aggregate demand), nor the persistent underutilization that is a feature of Keynesian and Kaleckian economics. There must be factors at play that are external to the firm but at the same time are affected by the individual firm's choices of utilization. In other words, as argued by Foley (2014), it is the pervasiveness of externalities in the economy that gives rise to its (post-) Keynesian features.

Thus, we assume that the firm faces a user cost of its own capital stock that is elastic to both its own choice of utilization and the average utilization rate, perhaps in its own sector. The dependence of the user cost on own-utilization is intuitive: an increase in the utilization rate of installed capacity increases its absolute wear and tear. In line with Greenwood *et al.* (1988), we assume a strictly convex dependence of the user cost on own utilization. The dependence on average utilization, on the other hand, captures the user cost of operating capital equipment in relative terms. Our argument is that no firm wants to be the first to ramp up utilization while everyone else is not, or equivalently that there are strong incentives to wait for other firms to increase utilization first and then do the same, so as not to incur first in the user cost increase associated with higher utilization. To capture such individual incentives to 'free ride' we postulate that the individual firm's *marginal* user cost decreases with average utilization: increasing own utilization becomes less costly after seeing other firms doing the same. This assumption ensures that there will be strategic complementarities in the model and, as we will show in the empirical section, is strongly supported by the available evidence for the United States.

The main implication is that the model turns from a description of an isolated firm to a strategic model in which forward-looking decision making about utilization and accumulation results in a best-response function: in particular, we show that the firm-level utilization rate increases in average utilization. Note that this is an immediate consequence of the user cost function described earlier: exogenous increases in average utilization make it advantageous for a firm to increase its usage of capacity, precisely because its *relative* user cost has fallen. Thus, the interaction between firms has the features of a coordination game where there are *strategic complementarities* between firms (Cooper, 1999, Chapter 2): the best-response choice of utilization by the individual firm increases in the level of activity chosen by the other firms in the economy.[2] Importantly for Kaleckian economics, if average utilization is used as a measure of demand by the firm, we obtain an explanation for why the desired rate of utilization should be treated as endogenous at the firm level.

In a symmetric general equilibrium, however, the firm-level utilization rate and average utilization have to be equal, in Cournot-Nash fashion. It is then not hard to show that the equilibrium path of the economy implies lower utilization than if firms were able to coordinate by committing to target a common utilization rate. Therefore, this finding provides a novel microeconomic argument for why decentralized economic decision-making based on profit maximization can lead in general to the accumulation of capital stock even in the presence of underutilized capacity.

In order to draw policy implications, we then consider two competing model closures that have been studied in the literature, namely (i) a Kaldor/Pasinetti parameterization in which labor supply grows

[2] Alternatively, the present approach can be seen as akin to the 'principle of social scaling' put forward by dos Santos (2017).

exogenously (Kaldor, 1956; Pasinetti, 1962) but income distribution is endogenous; and (ii) a closure featuring a conventional value for income shares and an endogenous labor supply in Classical/Kaleckian fashion (Foley and Michl, 1999, Chapter 6). A helpful device to visualize the implications of capacity underutilization through these two alternative model closures is the *growth-distribution schedule* (Foley and Michl, 1999, GD schedule in what follows), which relates either the real wage to the profit rate, or alternatively the level of an economy's social consumption per worker to the accumulation rate. As an illustration, consider Figure 1, which illustrates a version of the GD schedule featuring the wage share ω and a measure of consumption normalized by productivity χ on the vertical axis: the slope of the GD schedule is inversely related to the rate of capacity utilization which, for this picture, is parametrically set. Accordingly, the GD schedule represented in green in Figure 1 corresponds to a higher utilization rate than the orange GD schedule. Pick a point like E on the latter, corresponding to current values for the growth rate and income distribution. Fixing the growth rate at its value at point E, the Kaldor/Pasinetti closure can be used to pin down the labor share that could be attained if utilization increased so as to move onto the green GD schedule: the corresponding point is given by K in the figure. Vice versa, when the labor share is fixed at its starting value at E, the Classical/Kaleckian closure can be employed in order to obtain the growth rate that could be achieved if utilization increased: the corresponding point would be C in Figure 1. The segment KC identifies all possible growth/distribution combinations that, starting from a point like E, increase both the labor share and the profit rate so that both capitalists and workers are better off.

These considerations have the following implications. We show that under the Kaldor/Pasinetti closure, the equilibrium utilization rate implies a lower share of wages than the socially-coordinated rate, so that any policy intervention that ensures the socially-coordinated outcome will result in a redistribution toward wages that neither harms profitability nor growth: this would amount to move from a point like E to a point like K in Figure 1. On the other hand, the Classical/Kaleckian distributive closure implies the socially-coordinated growth rate to be strictly above its equilibrium counterpart: an increase in profitability and growth can be achieved through policy without redistributing away from wage-earning households. This would amount to move from a point like E to a point like C in Figure 1. The segment KC represent all possible growth/distribution points that make both classes better off relative to point E. It is therefore possible to strike bargains between wage-earners and profit-earners in order to achieve a point along the segment.

[Figure 1 about here.]

We also show the effects of fiscal policy in the model: first, the socially-coordinated utilization rate can be achieved through a user cost subsidy equal to the extent of strategic complementarities. Second, we show that such subsidy generates a multiplier effect in that the aggregate response to the policy is larger than the individual response (Cooper, 1999).

Finally, we use detailed Bureau of Economic Analysis state-by-industry data for the United States to test the plausibility of our hypothesis about the relevance of strategic complementarities. The individual best-response function (BR) obtained below can be directly estimated using a standard two-way fixed-effect panel data model, analogous to difference-in-differences. Utilization in state i, in sector j, at time t, $u_{i,jt}$, is modeled as a function of $u_{-i,jt}$: capacity utilization in sector j in all other states, and the state-industry labor share, ω_{ijt}. Our findings are supportive of the existence of statistically and economically meaningful strategic complementarities within industries in the US. The point estimates are also perfectly compatible with the parametric restrictions needed in the theoretical model. We also run a series of sensitivity checks, including a test proposed by Bai (2009) and fruitfully utilized by Totty (2017) that controls for unobserved cross-sectional dependences in the data. The robustness checks confirm our main hypothesis.

2 Motivating Evidence

The Great Recession and its aftermath provide an empirical motivation for this analysis that goes beyond the 'utilization controversy' (in the terminology put forward by Nikiforos, 2015) already mentioned above. Figure 2 displays three data series on (log-) real GDP at constant 2009 dollars in the United States, retrieved from the Bureau of Economic Analysis. The black line is the observed series for real GDP. The gray line shows the potential real GDP estimates released by the Congressional Budget Office in 2007. Finally, the red dashed line shows the revised estimates for potential real GDP, again by the CBO, in 2017. The comparison between the more recent estimate of potential GDP and actual GDP would point to conclude that the Great Recession was V-shaped like any other recession that preceded it. And yet, it obscures the fact that estimates of potential GDP have been consistently revised downward by the CBO, thus downplaying the extent to which the Great Recession has had a lasting impact on US growth.

[Figure 2 about here.]

To put it differently, if the relevant comparison is between the gray line and the black line, the Great Recession appears L-shaped as opposed to V-shaped: according to these measures, the US is still operating well below potential output almost a decade after the recession officially ended. Thus, the comparison provides an empirical motivation for studying the reasons why lasting underutilization of the installed capacity of an economy can emerge as an equilibrium outcome, and what the implications are for economic growth and income distribution.

3 Firm-level Choice of Utilization and Accumulation

Consider a price-taking capitalist firm in a closed economy without government. Its production possibilities are summarized by the Leontief technology $Y = \min\{uK, AL\}$ where: Y is the firm's output, homogeneous with capital stock K so that we can normalize its price to one; u denotes the rate of capacity utilization; L stands for labor; A is the current stock of labor-augmenting technologies, assumed to be constant throughout;[3] and the long-run output/capital ratio is normalized to one for simplicity.

[3]Assuming a constant rate of labor productivity growth would not change the qualitative implications of the model. The joint determination of endogenous technological change and utilization under strategic complementarities among firms is left for future research.

Time is continuous. Profit maximization requires to set $uK = AL$, which solves for labor demand $L = uK/A$. If the firm pays a real wage w to each worker, the share of wages in output will be $\omega \equiv w/A$. For the moment, suppose that the user cost of capital is captured by the constant depreciation rate $\delta > 0$. Following Foley and Michl (1999), we can characterize an economy by its labor productivity, output-capital ratio, and depreciation rate. Through the use of accounting identities, we obtain the *growth–distribution (GD) schedule*, which can be specified either in terms of the wage share–profit rate relation

$$\omega = 1 - \frac{r + \delta}{u} \tag{1}$$

or the consumption–growth, schedule which relates the real level of consumption per effective worker $\chi \equiv c/A$ to the gross accumulation rate $g + \delta$ through the equation

$$\chi = 1 - \frac{g + \delta}{u} \tag{2}$$

Notice that this version of the growth-distribution schedule has horizontal intercept equal to the rate of utilization u and vertical intercept equal to one. A higher utilization rate, everything else equal, makes the GD-schedule rotate out and right, allowing a higher growth rate for any level of social consumption per worker (except at the vertical intercept, of course), or a higher wage for any profit rate.

The main hypothesis made in this contribution is that the user cost of capital (which includes, but is not necessarily equal to the depreciation rate) responds to both the firm's own utilization of installed capacity u and the utilization chosen by other firms as captured by $\tilde{u}$, the average utilization rate. Thus, we postulate an adjustment cost function $\lambda(u; \tilde{u})$. The following restrictions on the user cost function are of crucial importance for what follows. First, we assume that the user cost increases more than proportionally with the firm's own utilization rate: denoting partial derivatives by subscripts, $\lambda_u > 0, \lambda_{uu} > 0$. Greenwood *et al.* (1988) have noted that this specification formalizes the Keynesian effects played by the 'marginal efficiency of investment' and the Keynesian notion of user cost for the individual firm. Second, we argued above that $\tilde{u}$ should have a negative impact on the *marginal* user cost. This assumption captures the individual firm's incentives to 'wait and see' what other firms are doing rather than increasing its own utilization first, and is required to generate a strategic complementarity, which is the focus of our contribution: $\lambda_{u\tilde{u}} < 0$. A convenient specification takes the log-linear form

$$\lambda(u; \tilde{u}) = \beta u^{\frac{1}{\beta}} \tilde{u}^{-\frac{\gamma}{\beta}}, \beta \in (0, 1), \gamma \in [0, 1 - \beta) \tag{3}$$

The size of the parameter γ determines the extent to which firms are interconnected. The special case $\gamma = 0$ corresponds to the isolated firms case, while $\gamma > 0$ implies a strategic environment and interconnectedness among firms.

As it is customary in Classical and post-Keynesian economics, we assume that only profit-earning (capitalist) households save in order to accumulate capital stock. Slightly less common in the literature (see however Foley and Michl, 1999; Tavani and Zamparelli, 2015) is to assume that capitalist households are forward-looking in their consumption, accumulation, and utilization decisions. This assumption is made here in order to rule out any potential ‘inefficiency’ result implied by a limited planning horizon, or by ‘rule of thumb’ behavior such as saving a constant fraction of income at all times. Here, the capitalist household discounts the future at a constant rate $\rho > 0$, and derives instantaneous logarithmic utility from its per-period consumption flow, denoted by c. Finally, assume that Say’s law holds: there is no independent investment demand function, so that capitalist savings are immediately invested at all times. This assumption allows a direct comparison with the Classical models presented in (Foley and Michl, 1999, Chapter 6). The accumulation constraint in continuous time is:

$$\dot{K} = (1-\omega)uK - c - \lambda(u;\tilde{u})K \tag{4}$$

Note that increasing the own rate of utilization raises the capitalist revenues $(1-\omega)uK$, but also increases the user cost of capital $\lambda(u;\tilde{u})$ given average utilization. As shown in Appendix A, the solution to a simple consumption and accumulation problem delivers the choice of capacity utilization at the firm level as a decreasing function of the labor share while increasing in average utilization, equivalent to a best-response function in the game theoretic sense:

$$u(\omega;\tilde{u}) = (1-\omega)^{\frac{\beta}{1-\beta}}\tilde{u}^{\frac{\gamma}{1-\beta}} \tag{BR}$$

The firm-level rate of utilization is inversely related to the labor share, but increasing (and concave) in average utilization, as displayed in Figure 3. The intuition for the former result is straightforward: an increase in the share of labor reduces revenues everything else equal: the firm can then lower its utilization in order to cut the user cost of capital. On the other hand, an increase in average utilization reduces the own marginal user cost of capital everything else equal, because of the individual incentive to ‘wait and see’ what other firms are doing before varying the own utilization rate. The firm can thus increase utilization up to the point where the marginal benefit of doing so—given by $(1-\omega)K$—is equal to the marginal user cost $\lambda_u(u;\tilde{u})K$ for a given average utilization rate. Finally, the dependence on average utilization can be thought of as capturing the endogeneity of the firm’s desired rate of utilization to a measure of demand. Appendix A also shows that the growth rate of consumption for the typical capitalist household satisfies:

$$g_c \equiv \frac{\dot{c}}{c} = (1-\omega)^{\frac{1}{1-\beta}}\tilde{u}^{\frac{\gamma}{1-\beta}} - \rho \tag{5}$$

4 Equilibrium Utilization and Growth

A general equilibrium for the present model is obtained imposing that firms best-respond to other firms’ choices, in Cournot-Nash fashion: hence, it requires that $u = \tilde{u}$. The equilibrium rate of utilization is easily found as

$$u(\omega) = (1-\omega)^{\frac{\beta}{1-\beta-\gamma}} \tag{U}$$

and is inversely related to the labor share, since $1-\beta-\gamma > 0$ by assumption. The intuition is simple: a higher wage share lowers the firm’s profits and thus the resources available for accumulation. But the firm can offset the higher wage costs by utilizing less its plants, thus reducing the user cost of capital. Even though the equilibrium utilization rate decreases in the labor share, it would be misleading at this point of the analysis to conclude, using the standard post-Keynesian jargon, that equilibrium utilization is profit-led by just looking at equation (U). First, we need to consider whether this economy can in principle achieve a higher rate of utilization of installed capacity: this will be shown below.

Before moving forward, we can obtain the equilibrium growth rate by setting again $u = \tilde{u}$ and imposing balanced growth so that consumption and capital stock grow at the same rate: $g_c = g_K = g$. We have:

$$g = (1-\beta)(1-\omega)^{\frac{1-\gamma}{1-\beta-\gamma}} - \rho \tag{6}$$

5 Socially-Coordinated Utilization and Growth

An interesting feature of this economy is that so long as a strategic context between firms is present—that is so long as $0 < \gamma < 1-\beta$—it will generally operate with spare capacity in equilibrium. To see this, suppose that profit-earners could coordinate so as to commit to the additional constraint that $u = \tilde{u}$ at all times.[4] Appendix B solves the accumulation problem under coordination, while Appendix C proves the following result.

Proposition 1. *Let $\gamma \in (0, 1-\beta)$. Then, the socially-coordinated choice of utilization is:*

$$u^*(\omega) = \left(\frac{1-\omega}{1-\gamma}\right)^{\frac{\beta}{1-\beta-\gamma}} \tag{U*}$$

and is strictly greater than its decentralized counterpart (U).

The parameter γ determines how large is the socially-coordinated utilization rate relative to the equilibrium rate. In the isolated firms case, $\gamma = 0$: the equilibrium rate and the socially-coordinated rate coincide. This result is important for two reasons: first, as long as firms operate within a strategic context, they will find it profit-maximizing to keep accumulating capital stock even though their capacity is not fully utilized. Second, the result shows that the individual component of the user cost function is not sufficient to generate underutilization: the presence of a strategic environment where firms' decisions are affected by other firms' choices is necessary for the economy to operate below full capacity in equilibrium. Figure 3 shows the equilibrium as opposed to the socially-coordinated utilization rate in this model.

[Figure 3 about here.]

[4]This constraint internalizes the average utilization externality faced by each firm. In standard economics jargon, one could call it 'Pareto-efficient,' because it would correspond to a benevolent planner's choice. However, one needs to remind that in this case the planner would maximize only the capitalists' welfare, an outcome that does not lend itself easily to societal efficiency considerations. We adopt the suggestion by Foley (2014) to use 'socially-coordinated' instead of 'efficient'.

Using (U*), we can then solve for the socially-coordinated growth rate as

$$g^* = \left(\frac{1-\omega}{1-\gamma}\right)^{\frac{1-\gamma}{1-\beta-\gamma}} (1-\beta-\gamma) - \rho \tag{7}$$

The GD schedule corresponding to equation (6) is plotted in orange in Figure 4. Because of the shape of the user cost function, the GD-schedule is strictly convex unlike in Foley and Michl (1999), where it is linear. On the other hand, the GD-schedule corresponding to (7) is plotted in green in Figure 4. The fact that it lies entirely above the equilibrium schedule (with the exception of the vertical intercept, which is equal to one for both schedules) is established in Propositions 2 and 3 below.

[Figure 4 about here.]

The relation between the equilibrium and socially-coordinated growth rate depends on how the model is closed. We turn to this issue in what follows, distinguishing between a Classical/Kaleckian distributive closure and a Kaldor/Pasinetti exogenous labor supply closure.

6 Model Closures and their Implications

6.1 Distributive Closure

It is well-known that a Classical model with a conventional distribution closure $\omega = \bar{\omega}$ delivers endogenous growth through capital accumulation alone (Michl, 2009). The following result establishes that, provided that there are strategic complementarities, the equilibrium growth rate is always below the socially-coordinated growth rate for any conventional value of the wage share below one.

Proposition 2. *Let $\omega = \bar{\omega} \in [0, 1)$. Then, $g \leq g^*$, with strict inequality if $\gamma \in (0, 1-\beta)$.*

Proof. See Appendix C. □

6.2 Exogenous Labor Supply

If labor supply grows exogenously, maintaining a constant unemployment rate over time requires the accumulation rate given by (6) to equal the growth rate of labor supply n. This holds true both at the equilibrium path and the socially-coordinated path, which deliver the same growth rate as a result. Conversely, income distribution is the accommodating variable as in Kaldor (1956) and Pasinetti (1962), and its long-run values will be different between the equilibrium and the socially-coordinated path. The equilibrium share of wages is:

$$\omega = 1 - \left[\frac{\rho + n}{1-\beta}\right]^{\frac{1-\beta-\gamma}{1-\gamma}} \tag{8}$$

with the usual comparative statics property according to which the labor (profit) share depends inversely (directly) on the discount rate. In supply-side balanced growth models, the labor share increases in the saving rate (this is the case, for instance, in Solow, 1956, provided that the elasticity of substitution between capital and labor be less than one): here, an increase in the discount rate implies less willingness to defer consumption, and therefore a lower saving rate by capitalist households.

In order to obtain the socially-coordinated share of labor, imposing $g = n$ in equation (7) gives:

$$\omega^* = 1 - (1-\gamma)\left(\frac{\rho + n}{1-\beta-\gamma}\right)^{\frac{1-\beta-\gamma}{1-\gamma}} \tag{9}$$

Comparing equations (8) with (9) delivers the following result.

Proposition 3. *Let $g = n > 0$. Then, $\omega \leq \omega^*$, with strict inequality if $\gamma \in (0, 1-\beta)$.*

Proof. See Appendix C. □

6.3 Implications

We have shown that the strategic complementarity between firms—as captured by a positive value of the parameter γ—delivers a coordination failure in this economy: the socially-coordinated utilization rate is higher than the decentralized equilibrium rate, but is not an equilibrium outcome. As such, the features of the interaction between firms resemble a Prisoner's Dilemma (PD) game. As pointed out by Bowles (2004, p. 38), PD interactions combine common interest with conflict aspects: here, the common interest feature on the firm's side is captured by the gains in profitability that could be achieved through social coordination; while the conflict feature is captured by the individually rational choice to under-utilize that arises from the incentives that each firm has to wait for other firms to ramp up utilization before doing the same.

Thus, the coordination failure implied by this model might shed some light on the behavioral motives behind the sluggish recovery in the United States following the Great Recession. One reason why the economy can operate with considerable slackness may be simply that firms hold back on their own utilization *because everyone else is doing the same*.

Comparing the socially-coordinated outcome and the equilibrium outcome and their implications using the two different closures is useful to draw policy implications. Below, we will distinguish between government spending to boost utilization and the possibility of bargained Pareto-improvements between capital and labor.

6.3.1 Government Policy and the Multiplier

Suppose that a government authority can subsidize the user cost at a rate s, and—for simplicity—taxes capitalist income lump-sum by an amount τ while running a balanced budget.[5] The capitalist's budget constraint modifies to

$$(1-\omega)uK - \tau - c - \lambda(u, \tilde{u})K(1-s) \tag{10}$$

Solving the corresponding optimal control problem, we have the following result.

[5]Setting $\tau = 0$ amount to impose a deficit-financed user cost subsidy.

Proposition 4. *The subsidy that decentralizes the socially-coordinated utilization rate is equal to γ, the extent of strategic complementarities. Further, the aggregate response to an increase in the user cost subsidy is always greater than the individual firm's response. The resulting 'fiscal multiplier' is equal to $\frac{1}{1-\frac{\gamma}{1-\beta}}$.*

Proof. See Appendix C. □

These results point to the effectiveness of demand policies in solving the coordination problem that arises as a result of decentralized decision-making by firms in this framework.

6.3.2 Bargained Pareto-Improvements

An alternative to explicit government intervention could be the possibility of mutually beneficial bargains between capital and labor. Starting from an equilibrium growth-distribution point, the two closures can be utilized in order to identify, respectively, the highest labor share that this economy can achieve at the current growth rate and the highest profit (and growth) rate that can be attained at the current wage share. These alternative possibilities are represented in Figure 4, which mirrors Figure 1 but displays the GD schedules corresponding to equations (6) and (7) in orange and green respectively. As before, point E represents a starting point equilibrium configuration; while point K depicts the highest wage share that could be attained at the socially-coordinated path under the Kaldor/Pasinetti closure, and point C illustrates the growth rate that could be achieved under the Classical/Kaleckian closure. The final argument made in this paper starts from the consideration, which is apparent from Figure 4, that the existence of attainable improvements in both growth (profitability) and in the workers' distributional position over the equilibrium outcome implies the opportunity for mutually beneficial bargains between capital and labor.

We are interested in solving for bargains between workers and capitalists that can in principle achieve any point on the KC portion of the efficient GD-schedule, which makes both classes better off. A convenient way of doing so is to use the generalized Nash (1950) bargaining solution, which maximizes a weighted geometric average of the gains from a bargain. Observing that the accumulation rate solving the capitalists' problem always satisfies $g = r - (\lambda + \rho)$, denote the wage share and gross profit rate corresponding to point E—the fallback positions for workers and capitalists respectively—by $\bar{\omega}$ and $r(n) = n + \lambda + \rho$. The workers' gain from a successful bargain is $\omega - \bar{\omega}$, while the capitalists' gain is

$$
\begin{aligned}
r^*(\omega) - r(n) &= g^*(\omega) + \lambda - \rho - (n + \lambda - \rho) \\
&= g^*(\omega) + \rho - (n + \rho) \\
&= (1 - \beta - \gamma) \left(\frac{1 - \omega}{1 - \gamma} \right)^{\frac{1-\gamma}{1-\beta-\gamma}} - n
\end{aligned}
$$

Denoting the workers' bargaining power by $\eta \in [0, 1]$, the generalized Nash bargaining amounts to solving:[6]

$$\text{Choose } \omega \in [0,1] \quad \text{to mazimize} \quad \eta \ln(\omega - \bar{\omega}) + (1-\eta)\ln\left[r^*(\omega) - r(n)\right] \tag{11}$$

The solution, derived in Appendix D, achieves the socially-coordinated utilization rate by construction, and involves workers getting their fallback position plus a share of the capitalists' gains from bargaining that increases in their bargaining power. Observe that it pins down both a higher wage share and a higher growth rate, thus providing a flavor similar to the paradox of costs. It can be written as:

$$\omega = \bar{\omega} + \frac{\eta}{(1-\eta)u^*}(g^* - n) \tag{12}$$

7 Empirical Evidence

To test the significance of the strategic complementarities that drive our theoretical results, we begin by noting that the best-response function (BR) can be written in log form as follows:

$$\ln u = \frac{\beta}{(1-\beta)}\ln(1-\omega) + \frac{\gamma}{(1-\beta)}\ln \tilde{u} \tag{13}$$

which implies an estimating equation of the form:

$$\ln u_{i,jt} = \beta_1 \ln(1-\omega_{ijt}) + \beta_2 \ln u_{-i,jt} + \xi_{ij} + \phi_t + \varepsilon_{ijt} \tag{14}$$

Where $u_{i,jt}$ is capacity utilization in region i, in sector j, at time t, $u_{-i,jt}$ is capacity utilization in all other regions of the economy for the same sector (presumably, reflecting the output of the national competitors of firms in industry j in region i), ω_{ijt} is the region-industry specific labor share, ξ_{ij} is a region-industry specific fixed-effect, ϕ_t is a time-specific fixed-effect, and ε_{ijt} is an idiosyncratic error term.

To make (14) operational, we obtain data on state-by-industry output for the United States from the Bureau of Economic Analysis (BEA) Regional Economic Accounts. The industry data is aggregated according to the North American Industry Classification System (NAICS). We obtain data on all twenty two-digit NAICS sectors for each of the 50 U.S. States, from 1997 onward (the beginning of NAICS usage in the regional economic accounts). To calculate $u_{i,jt}$ and $u_{-i,jt}$ in each sector in each state, we adopt the following procedure. First, we calculate $Y_{-i,jt}$—output in sector j in all 'not i' states—as:

$$Y_{-i,jt} = Y_{jt} - Y_{i,jt} \tag{15}$$

Where Y_{jt} is national output in sector j at time t. We then use the Hodrick-Prescott (HP) filter and the Hamilton (2017) filter to obtain two estimates of potential output, $Y^p_{i,jt}$, $Y^p_{-i,jt}$, for both $Y_{i,jt}$ and

[6] Note that, since labor productivity is assumed to be constant in this analysis, we can alternatively use the wage share ω or the real wage rate w as an argument of the maximization problem below. The former leads to cleaner results, and it is used in the derivation of equation (11).

$Y_{-i,jt}$, as the trend-component of each series.[7] Although the HP filter is known to (a) produce series with spurious dynamic relations not related to the underlying data-generating process, (b) create starting and ending values that differ from those in the middle of the series, and (c) make use of smoothing parameters at odds with those suggested by a statistical formulation of the problem, constructing measures of capacity utilization using the Hamilton (2017) filter is no free lunch, because it requires the loss of a number of observations by construction.[8] Thus, we use both methods to make our results as robust as possible. Finally, we calculate $u_{i,jt}$ and $u_{-i,jt}$ as:

$$u_{i,jt} = \frac{Y_{i,jt}}{Y^p_{i,jt}}; \quad u_{-i,jt} = \frac{Y_{-i,jt}}{Y^p_{-i,jt}} \tag{16}$$

Once we obtain estimates of state-sector-specific capacity utilization and 'average' capacity utilization ($u_{-i,jt}$) we also construct values for the labor share for each industry in each state by taking the value of wage and salary compensation in the sector over the sum of wage and salary compensation and the gross operating surplus of the sector. The sample consists of 19 years of observations, over 20 industries and 50 states, resulting in a sample count of 19,000. From this, we drop all state-industry pairs ($n = 3$) which report negative values for the gross operating surplus in a particular year (implying a labor share greater than 1)[9]. The final sample count is thus $N = 18,493$. Table 1 presents sample means for the labor share and capacity utilization (using both measures of potential output) for each NAICS sector.

[Table 1 about here.]

We note that the log of our capacity utilization measure corresponds to a measure of the output gap (in sector i) in percentage terms: $\ln u_{ijt} = \ln Y_{ijt} - \ln Y^p_{ijt} \approx (Y_{ijt} - Y^p_{ijt})/Y^p_{ijt}$, so that the regression equation (14) amounts to finding the elasticity of the output gap in sector i to the output gap in all the 'non-i' sectors, which is directly related to the extent of strategic complementarities. Further, we note that although the sample mean of our capacity utilization estimates are close to one, there are many state-industry-year cells which display significant amounts of excess capacity—including minimum values of 0.29 for the Hodrick-Prescott filter series, and 0.04 for the Hamilton (2017) filter series. In section 7.1 we obtain additional estimates of capacity utilization by tweaking the logic of the Hamilton (2017) filter a number of ways. We find that these various ways of constructing capacity utilization suggest more or less excess capacity (for example, when state-industry fixed-effects are accounted for in construction of the utilization measure the mean value for capacity utilization falls to 0.69), but do not qualitatively change our findings regarding the importance of strategic complementarities. In other words, the covariance of the joint distribution of individual and average capacity utilization is invariant

[7] For the HP filter we use a smoothing parameter of 100 given that our sample is made of annual data.

[8] In particular, the cyclical component of the series is obtained by a regression of the dependent variable at time $t + h$ on the four most recent values of the variable as of time t. The first value in the filtered series requires at least z lags, where z is equal to the gap between $t + h$ and t plus the number of lags as of time t. For a more detailed description, see Hamilton (2017).

[9] The dropped state-industry pairs are: Mining in Maine, Mining in Nebraska, and Administrative and Waste Management Services in Wyoming.

with respect to the choice of statistical filter.

We begin by estimating equation (14) in logarithmic form as it is written. For completeness, Appendix E presents results for estimation in levels. We adopt several strategies to address the obvious potential for simultaneity between $u_{i,jt}$ and $u_{-i,jt}$. First, we include both state-industry-fixed effects and year-fixed effects. The former control for time-invariant unobserved state-industry specific heterogeneity, the latter control for common secular trends in utilization across sectors (i.e. they address aggregate demand shocks that simultaneously positively or negatively impact utilization in sector j in multiple states). Second, we include lagged values for utilization. This holds constant recent trends in $u_{i,jt}$ which may be responsible for both $u_{i,jt}$ and $u_{-i,jt}$, for example, if there is substantial serial correlation in economic activity within sectors between certain states.

Table 2 presents our initial results. Columns (1) and (2) present the results from our different capacity utilization measures, and Columns (3) and (4) add lags to the specification from Column (1). We cluster the standard-errors at the industry level to address the possibility of serial correlation, which would otherwise bias our standard errors downward in the absence of clustering.

[Table 2 about here.]

The results presented in Table 2 support the existence of significant strategic complementarities in the firm's choice of capacity utilization. The size of the parameter γ implied by our estimation lies between 0.5 and 0.65, and is robust to the inclusion of several lags of the dependent variable. Furthermore, in every regression the values of γ and β implied by our estimation satisfy our theoretical restriction that $\gamma < (1 - \beta)$. The direct interpretation of the regression coefficients suggests that an exogenous 10% increase in the 'average' rate of capacity utilization within some sector j induces firms in that sector to increase their own rates of utilization between 5% and 7%.

No firm—or, to make the analogy cleanly to our data, no regional cluster of firms—in a specific industry wants to be the first in the industry to alter its rate of capacity utilization because the anticipated relative user costs are lower when other firms (or regional clusters of firms) within the same industry are doing the same. Thus, the incentive to wait on behalf of individual firms produces a version of the 'beauty contest' dynamics described by Keynes in Chapter 12 of *The General Theory*. Each individual firm has strong incentives to hold its rate of utilization constant until other firms alter their usage of capacity, but all other firms are making decisions in a similar fashion. Thus, whether or not the economy can achieve an increase in the average rate of utilization (and avoid chronic under-utilization of capacity) depends on whether or not individual firms in an industry expect the average firm to increase its rate of utilization, which in turn depends on a similar set of expectations. Given the empirical relevance of these strategic complementarities, our theoretical findings of the resulting coordination failure lend support to amending Keynes (1936)' statement on investment policy to the case of utilization, namely: '[T]here is no clear evidence from experience that the investment policy which is socially advantageous coincides with that which is most profitable' (p.157). Strategic complementarities make it possible that no firm has an incentive to increase its utilization of capacity beyond some rate less than full utilization, despite the fact that all would be better off by coordinating to a higher utilization rate.

7.1 Sensitivity Analysis

We then run a number of robustness checks on the empirical results presented above. First, although the inclusion of time-fixed effects in our regression should capture any common macroeconomic shocks (such as a change in aggregate demand) experienced by all sectors, there may nonetheless be some concern that the empirical finding of the co-movement of capacity utilization across regions within sectors merely reflects changes in sector-specific demand conditions for the entire United States. To address this concern, we propose the following test. We note that while changes in demand for *tradables* should be equally distributed across all regions, the demand for *non-tradables* depends largely on local demand, so that—after using fixed-effects to control for common time trends—in the absence of strategic complementarities, changes in utilization in non-tradable sectors in a region should reflect only changes in local demand conditions. Thus, changes in utilization in non-tradable sectors should be uncorrelated with changes in average sector utilization if firms are not taking the behavior of other firms into account when making their own production decisions.

Column (1) of Table 3 presents results from estimating our main specification restricting the sample to non-tradable sectors only. Following Mian and Sufi (2014), we define non-tradable industries as the combination of the retail sector and the accommodation and food services sector. The identifying assumption is that the supply of non-tradables in state i is uncorrelated with the demand for non-tradables in all other states (after controlling for common aggregate shocks using time-fixed effects).

Second, we test out two modifications of the capacity utilization series. First, we allow the inclusion of state-industry fixed effects when applying the Hamilton (2017) filter. The resulting series have means for u_{ijt} and $u_{-i,jt}$ of 0.69 and 0.88, respectively, and are therefore suggestive of greater levels of underutilization than either of the two methods of construction above.[10] Column (2) of Table 3 presents these results. The second modification is presented in Column (3). Here we apply the Hamilton (2017) filter separately to each panel in calculating the capacity utilization series. In this case, we find the mean values of utilization are similar to those in the earlier series—that is, approximately one.

[Table 3 about here.]

In every case, the results of the sensitivity analysis support our hypothesis. In Column (1) the results indicate that even in non-tradables producing sectors, capacity utilization responds to changes in the level of average utilization within the sector. Given that demand for non-tradables is by definition local, the only two interpretations of this result are either that local demand for non-tradables industries happens to always move in the same direction in all regions of the United States, or that firms are selecting rates of utilization based on the choices of other firms in the same industry. The implausibility of the first interpretation (as argued by Mian and Sufi, 2014) leads us to believe strongly in the likelihood of the second. The results in Columns (2) and (3) lend further support to our findings: they provide evidence that our results are not primarily driven by the way the capacity utilization measure is constructed. Thus, we conclude that the empirical evidence strongly supports our theoretical argument.

[10]The time-path of the series, however, is similar across all methods.

7.2 Interactive Fixed-Effects Estimator

Consider again the simple two-way fixed effects model in equation (14) above. The identifying assumption for the fixed-effect estimator is:

$$\mathbf{E}[\epsilon_{ijt}|ln(u_{-i,jt}), ln(1-\omega_{ijt}), \zeta_{ij}, \phi_t] = 0 \tag{17}$$

If for some reason there are unobserved cross-sectional dependencies in the data, this assumption will not be sufficient to identify our parameter of interest, β_2. In the context of region-by-industry data, such cross-sectional dependencies are likely. Two regions may experience simultaneous labor demand shocks of similar magnitudes—due to similarities in regional industrial composition, or in the skill-composition of the workforce across particular region-industry pairs. One can think of many additional examples of omitted variables that bias the estimate of β_2 either up or down. Biased technical change, competition from abroad, regionally-specific changes in demographic trends—all of these macroeconomic shocks are potential sources of unobserved heterogeneity arising from cross-sectional dependencies not addressed in the traditional two-way fixed-effect estimator. In such cases, we can capture the cross-sectional dependence among units in the structure of the error term:

$$\epsilon_{ijt} = \lambda'_{ij} f_t + a_{ijt} \tag{18}$$

where f_t is an $(r \times 1)$ vector of unobserved time-specific common factors affecting multiple cross-sectional units, λ_{ij} is an $(r \times 1)$ vector of factor loadings that capture unit-specific differences in the effect of the common shock, and a_{ijt} is the true idiosyncratic error term. Assuming the common factors and factor loadings can be estimated, the identifying assumption reduces to:

$$\mathbf{E}[a_{ijt}|ln(u_{-i,jt}), ln(1-\omega_{ijt}), \zeta_{ij}, \phi_t, \lambda'_{ij} f_t] = 0 \tag{19}$$

which is more plausibly satisfied than (17). Bai (2009) details a way of estimating models with a multi-factor error structure, such as the one above, via an interactive fixed-effects approach. Given an initial guess of the regression coefficients, Bai (2009) shows that one can iteratively estimate the factor structure and regression coefficients until the percent change in the sum of the squared residuals falls below some pre-specified tolerance level. We adopt this approach in estimating an interactive fixed-effects version of the model above. As an initial guess for our regression coefficients, we use the coefficients from the baseline two-way fixed effects model. We use a tolerance level of 10^{-9}. Standard errors are estimated as in Section 6 of Bai (2009), again adjusting for clustering at the industry-level.[11]

For the method suggested by Bai (2009) to work, the number of common factors must by specified prior to the estimation. For robustness, we estimate the model for a range of possible common factors.

[11] As pointed out by Bai (2009) and Totty (2017), violation of the i.i.d. assumption of the residuals may result in estimates that are consistent, but biased. Gomez (2015) suggests allowing for the inclusion of additional factors until the residuals are approximately i.i.d., and Bai (2009) suggests a number of bias-correction procedures for such cases. Appendix (F) presents plots of the distribution of the residuals for models with varying numbers of common factors in order to assess the likelihood of this bias. The distribution of the residuals seems to offer support for the i.i.d. assumption.

Moon and Weidner (2015) show that the estimator will generally perform well even if the number of factors is over-estimated, but performs poorly when too small a number of factors is included.

[Table 4 about here.]

Table (4) presents the results for the interactive fixed-effect estimation. The columns indicate the number of common factors estimated. The results support the findings of the previous section. For each number of pre-specified common factors, changes in $\tilde{u}_{-i,jt}$ have a positive, statistically significant effect on u_{ijt}, and the implied values of γ and β fall within the range suggested by the simple two-way fixed effects model.

8 Conclusion

In this paper, we built a growth and distribution model in which firms, rather than acting in isolation, consider the effect of other firms' utilization choices in choosing how much to utilize their installed capacity. Using a user cost function with arguments both the firm-level utilization and the average utilization rate, we showed that it is profit-maximizing for a firm to increase own utilization when average utilization increases. This feature of the model is appealing because it provides a novel microeconomic rationale for the endogeneity of desired utilization at the firm level based on strategic complementarities (Cooper, 1999; Bowles, 2004; Foley, 2016) and the extent to which firms are connected with similar firms in the economy. Nikiforos (2015) has provided an alternative justification based on increasing returns: our result is complementary to his.

Differently from Nikiforos (2015), however, we also considered the general equilibrium implications of this model. First, by comparing the equilibrium choice of utilization with its socially-coordinated counterpart, we showed that this economy accumulates capital stock but at the same time it has underutilized capacity. As such, the model provides an answer to the longstanding questions raised by Auerbach and Skott (1988); Kurz (1986); Shaikh (2009); Skott (2010, 2012). Specifically, the answer is that it is profit-maximizing to keep excess capacity given the presence of interconnectedness and strategic complementarities among firms.

Importantly, individual forward-looking profit maximization does not lead to first-best outcomes in this model. If firms were able to internalize the effect of their own choices on average utilization so as to commit to a coordinated solution, the resulting utilization rate would always be higher than its decentralized counterpart. The implications of this result for growth and distribution, in turn, depends on the way the model is closed. we showed that the two benchmark model closures in the literature—the Kaldor/Pasinetti exogenous labor supply closure and the Classical distributive closure—can be used in order to identify the boundaries of potential improvements that would involve both a higher share of labor and a higher growth rate (or profit rate) than in equilibrium. The generalized Nash bargaining solution can then provide a simple understanding of how to divide the gains from higher utilization between capital and labor. Further, we carried a simple policy exercise that showcases how to implement a socially-coordinated utilization rate, and the importance of the fiscal multiplier.

The empirical analysis we carried using BEA regional data for the United States lends strong support for our theoretical argument; our findings are robust to different measures of utilization, to restricting the sample to non-tradable sectors only, and to using an interactive fixed-effects estimator that controls for unobservable common trends in the sample. The implied extent of strategic complementarities is substantial, and amounts to an elasticity of sector-level utilization in one region to average utilization in the same sector but in every other region between .5 and .7.

The most important takeaway from this analysis is that there are strong reasons to expect economies to operate below full capacity, potentially for long periods of time. The reason why firms might chose not to ramp up production is that they simply do not see similar firms doing it, most likely because of lack of sufficient demand. If this is true, this paper casts doubt on the famous argument by Duménil and Lévy (1999) according to which one should think about the economy as being 'Keynesian in the short run but Classical in the long run:' there are empirically-supported theoretical reasons to believe that underutilization can be a long run feature of an economy, and therefore that demand policies aimed at stimulating demand can have effects beyond the short run.

Finally, it would be difficult not to observe the relationship between this simple model and the current global conjuncture involving falling labor shares in many advanced countries accompanied by lackluster growth performances in the aftermath of the global recession that followed the US financial crisis of 2007. If, as argued here, excess capacity can arise as an equilibrium phenomenon, then cooperative policies that improve both profitability and growth on the one hand, and the workers' distributional position on the other, are possible as a result; but they require a change in the 'rules of the game' so as to enforce the socially coordinated solution as an equilibrium. In this sense, the present paper provides a simple argument for why the social contract at the heart of the so-called 'capital-labor accord' of the early post-WWII era gave rise to fast economic growth accompanied by a worker-friendly economic environment, while at the same time being prone to fail. If one agrees with the argument made here, it is possible that such outcomes are attainable again: but given the highly conflictual nature of the current labor relations, it would be difficult to envision a renewed collaboration between capital and labor in the near future.

A Dynamic Optimization

Suppose that the typical capitalist household has logarithmic preferences over consumption streams, and discounts the future at a constant rate $\rho > 0$. Then, the household solves:

$$\begin{aligned}
\text{Given } \tilde{u}, \text{ Choose} \quad \{c(t), u(t)\}_{t\in[s,\infty)} \quad & \text{to maximize} && \int_s^\infty e^{-\rho(t-s)} \ln c(t) dt \\
& \text{subject to} && \dot{K} = (1-\omega)u(t)K(t) - c(t) - \lambda[u(t);\tilde{u}]K(t) \\
& && K(s) \equiv K_s > 0, \text{ given} \\
& && \lim_{t\to\infty} e^{-\rho(t-s)} K(t) \geq 0
\end{aligned} \tag{20}$$

Observe first that the problem stated in (20) involves a strictly concave objective function to be maximized over a convex set. Thus, the standard first-order conditions on the associated current-value Hamiltonian

$$\mathcal{H} = \ln c + \mu[u(1-\omega)K - c - \lambda(u;\tilde{u})K]$$

will be necessary and sufficient for an optimal control. They are:

$$\begin{aligned} c^{-1} &= \mu & (21)\\ 1-\omega &= \lambda_u(u,\tilde{u}) & (22)\\ \rho\mu - \dot{\mu} &= \mu[(1-\omega)u - \lambda(u;\tilde{u})] & (23)\\ \lim_{t\to\infty} e^{-\rho t}\mu(t)k(t) &= 0 & (24) \end{aligned}$$

Solving (22) for the rate of utilization under the specific functional form (3) gives (BR). To obtain the Euler equation for consumption, differentiate (21) with respect to time and use (21) and (23) to get:

$$g_c \equiv \frac{\dot{c}}{c} = (1-\omega)u(\omega;\tilde{u}) - \{\lambda[u(\omega;\tilde{u})] + \rho\}.$$

Using both (BR) and (3) while imposing a balanced growth path where consumption and capital stock grow at the same rate gives (5).

B The Socially-Coordinated Solution

The socially-coordinated problem is solved imposing that firms can commit to $u = \tilde{u}$ at all times. Accordingly, the accumulation problem (20) is solved under the modified accumulation constraint

$$\dot{K} = u(1-\omega)K - c - \beta u^{\frac{1-\gamma}{\beta}}K \tag{25}$$

The first-order condition on consumption is the same as (21) above. On the other hand, the choice of utilization and the costate equation satisfy the first-order conditions which, once again, are necessary and sufficient for an optimal control:

$$\begin{aligned} 1-\omega &= (1-\gamma)u^{\frac{1-\beta-\gamma}{\beta}} & (26)\\ \rho\mu - \dot{\mu} &= \mu[u(1-\omega) - \beta u^{\frac{1-\gamma}{\beta}}] & (27) \end{aligned}$$

Solving equation (26) for utilization gives (U*). To obtain the socially-coordinated growth rate (7), simply impose a balanced growth path.

C Proofs

To prove Proposition 1, consider that that, using (U) and (U*),

$$\frac{u^*}{u} = \left(\frac{1}{1-\gamma}\right)^{\frac{\beta}{1-\beta-\gamma}} > 1$$

since $0 < \gamma < 1 - \beta$ by assumption.

***

To prove Proposition 2, start by adding ρ to both sides of equations (7) and (6), take logs, and subtract the second from the first to obtain:

$$\begin{aligned} D_g &\equiv \ln(g^* + \rho) - \ln(g + \rho) \\ &= \ln(1 - \beta - \gamma) - \ln(1 - \beta) - \tfrac{1-\gamma}{1-\beta-\gamma} \ln(1 - \gamma) \end{aligned}$$

Certainly, $D_g = 0$ under $\gamma = 0$. To show that $D_g > 0$ under $\gamma \in (0, 1 - \beta)$, differentiate with respect to γ to see that

$$\frac{\partial D_g}{\partial \gamma} = -\frac{\beta}{(1 - \beta - \gamma)^2} \ln(1 - \gamma) > 0, \text{ since } 0 < \gamma < 1 - \beta.$$

Hence, the difference between the two growth rates grows with γ under the required restriction on the parameters, and this proves the claim.

***

As for Proposition 3, showing that $\omega^* > \omega$ is tantamount to showing that $\ln(1-\omega) - \ln(1-\omega^*) > 0$. We have that

$$\begin{aligned} D_\omega &\equiv \ln(1 - \omega) - \ln(1 - \omega^*) \\ &= \frac{1 - \beta - \gamma}{1 - \gamma} [\ln(1 - \beta - \gamma) - \ln(1 - \beta)] - \ln(1 - \gamma) \end{aligned}$$

and

$$\frac{\partial D_\omega}{\partial \gamma} = -\frac{\beta}{(1 - \gamma)^2} [\ln(1 - \beta - \gamma) - \ln(1 - \beta)]$$

Hence, the difference D_ω increases in γ provided that the term in brackets is negative. This is certainly true under $0 < \gamma < 1 - \beta$, since $\partial \ln(1 - \beta - \gamma)/\partial\gamma < 0$.

***

To prove the first claim of Proposition 4, consider that the first-order necessary condition for the choice of utilization with the tax and subsidy solves for the firm-level utilization as

$$u = \left(\frac{1 - \omega}{1 - s}\right)^{\frac{\beta}{1-\beta}} \tilde{u}^{\frac{\gamma}{1-\beta}} \tag{28}$$

Imposing the equilibrium condition $u = \tilde{u}$, we find

$$u^{subs} = \left(\frac{1-\omega}{1-s}\right)^{\frac{\beta}{1-\beta-\gamma}} \tag{29}$$

The comparison with equation (U*) makes it clear that $s = \gamma$ achieves the socially-coordinated utilization rate.

To prove the second claim, differentiate equations (29) and (28) (after taking logs for simplicity) with respect to the subsidy s to see that

$$\frac{\partial \ln u^{subs}}{\partial s} = \frac{\beta}{1-\beta-\gamma}\frac{1}{1-s} > \frac{\partial \ln u}{\partial s} = \frac{\beta}{1-\beta}\frac{1}{1-s} \iff \gamma \in (0, 1-\beta).$$

The size of the fiscal multiplier μ can be recovered by dividing the aggregate response by the individual response. We have that

$$\mu = \frac{1-\beta}{1-\beta-\gamma} = \frac{1}{1-\frac{\gamma}{1-\beta}}$$

D Generalized Nash Bargaining

The first-order condition, which is necessary and sufficient for this problem, is simply

$$\begin{aligned} \frac{\eta}{\omega - \bar{\omega}} &= \frac{1-\eta}{g^* - n}\left(\frac{1-\omega}{1-\gamma}\right)^{\frac{\beta}{1-\gamma-\beta}} \\ &= \frac{1-\eta}{g^* - n}u^* \end{aligned}$$

where the second equality uses equation (U*). Equation (12) follows immediately.

E Additional Sensitivity Analysis

[Table 5 about here.]

Table 5 presents results for estimating our regression equation in levels, rather than logs. While the level estimates do not allow a direct estimation of either γ or β in the model, they provide an additional check of our results. We find statistically significant, economically meaningful effects parallel to those found in the body of the paper.

F Residual Density Plots for Common Factors

[Figure 5 about here.]

[Figure 6 about here.]

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Tables

		HP	HP	Hamilton (2017)	Hamilton (2017)
Sector	ω_{ijt}	$u_{i,jt}$	$u_{-i,jt}$	$u_{i,jt}$	$u_{-i,jt}$
Agriculture	0.17	0.999	0.999	1.04	0.97
Mining	0.28	1.03	1.00	1.26	1.28
Utilities	0.22	1.00	1.00	0.99	0.93
Construction	0.49	0.997	0.998	0.98	0.96
Manufacturing	0.40	0.999	1.00	0.96	0.97
Wholesale Trade	0.48	1.00	1.00	1.01	1.02
Retail Trade	0.55	1.00	1.00	0.95	0.96
Transportation	0.49	1.00	1.00	1.02	0.99
Information	0.30	0.999	1.00	0.97	0.99
Finance and Insurance	0.42	0.998	0.999	0.99	0.99
Real Estate	0.03	1.00	1.00	1.02	1.03
Professional/Scientific/Tech. Services	0.52	1.00	1.00	1.03	1.04
Management	0.78	0.998	1.00	1.10	1.00
Administrative Services	0.58	1.00	1.00	1.04	1.01
Educational Services	0.84	1.00	1.00	1.06	0.98
Healthcare	0.74	1.00	1.00	1.06	1.06
Arts and Entertainment	0.48	0.999	1.00	0.98	0.91
Accommodation and Food Services	0.58	1.00	1.00	1.00	0.98
Other Services	0.55	1.00	1.00	0.93	0.92
Public Services	0.69	1.00	1.00	1.00	1.02
Full Sample Means	0.48	1.00	0.999	1.02	1.00

Table 1: Sample Means, by Sector

	(1)	(2)	(3)	(4)
	$ln(u_{ijt})$	$ln(u_{ijt})$	$ln(u_{ijt})$	$ln(u_{ijt})$
$ln(1-\omega_{ijt})$	0.112***	0.451***	0.122***	0.129***
	(0.0314)	(0.109)	(0.0231)	(0.0262)
$ln(\tilde{u}_{-i,jt})$	0.720***	0.727***	0.573***	0.555***
	(0.0515)	(0.0488)	(0.113)	(0.112)
$ln(u_{ij,t-1})$			0.401***	0.438***
			(0.0872)	(0.0929)
$ln(u_{ij,t-2})$				-0.0821**
				(0.0350)
γ	0.65	0.50	0.51	0.49
β	0.10	0.31	0.11	0.11
N	18,943	11,964	17,946	16,949
R^2	0.261	0.372	0.428	0.425
HP Filter	Y	N	Y	Y
Hamilton Filter	N	Y	N	N
Time FE	Y	Y	Y	Y
State-Industry FE	Y	Y	Y	Y

Table 2: Estimation Results

Notes: Standard errors in parenthesis, clustered at the industry level. * 0.10 ** 0.05 *** 0.01.

	(1) Non-Tradables	(2) Alternate Series 1	(3) Alternate Series 2
$ln(1-\omega_{ijt})$	0.148*	0.416***	0.224***
	(0.0180)	(0.114)	(0.0536)
$ln(\tilde{u}_{-i,jt})$	0.674**	0.680***	0.586***
	(0.0319)	(0.0774)	(0.0534)
γ	0.59	0.48	0.48
β	0.13	0.29	0.18
N	1,900	11,964	15,952
R^2	0.609	0.307	0.269
HP Filter	Y	N	N
Hamilton Filter	N	Y	Y
Time FE	Y	Y	Y
State-Industry FE	Y	Y	Y

Table 3: Sensitivity Checks

Notes: Standard errors in parenthesis, clustered at the industry level. *0.10 **0.05 ***0.01. Column (1) presents results for only non-tradables industries. Column (2) uses a modified version of the capacity utilization series, constructed with the inclusion of state-industry fixed effects. Column (3) presents a second alternative construction of the capacity utilization series, applying the Hamilton (2017) filter to each panel individually.

# of Common Factors										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$ln(1-\omega_{ijt})$	0.147***	0.139***	0.231***	0.199***	0.195***	0.206***	0.171***	0.148***	0.384***	0.350***
	(0.0277)	(0.0281)	(0.0573)	(0.0486)	(0.0535)	(0.0636)	(0.0568)	(0.0518)	(0.0745)	(0.0836)
$ln(\tilde{u}_{-i,jt})$	0.615***	0.642***	0.571***	0.603***	0.633***	0.696***	0.687***	0.733***	0.445***	0.657***
	(0.119)	(0.175)	(0.187)	(0.100)	(0.0888)	(0.0761)	(0.0963)	(0.0604)	(0.103)	(0.0733)
N	18,943	18,943	18,943	18,943	18,943	18,943	18,943	18,943	18,943	18,943
CD Test Statistic	9.257***	12.050***	6.737***	8.310***	7.015***	7.436***	9.808***	10.068***	17.930***	18.896***

Table 4: Interactive Fixed-Effects Estimates

Notes: Standard errors in parenthesis, clustered at the industry-level. *0.10 **0.05 ***0.01. Each column reports a different number of pre-specified common factors. The cross-sectional dependency test statistic is based on the test for weak cross-sectional dependence in Peseran (2015).

	(1)	(2)	(3)	(4)
	u_{ijt}	u_{ijt}	u_{ijt}	u_{ijt}
$(1-\omega_{ijt})$	0.226*	0.340***	0.377***	0.603***
	(0.121)	(0.0440)	(0.0531)	(0.127)
$\tilde{u}_{-i,jt}$	0.844***	0.551***	0.537***	0.549***
	(0.0210)	(0.107)	(0.123)	(0.0669)
$u_{ij,t-1}$		0.364***	0.382***	
		(0.0241)	(0.0764)	
$u_{ij,t-2}$			0.0224	
			(0.0248)	
N	18,943	17,946	16,949	11,964
R^2	0.121	0.566	0.477	0.226
HP Filter	Y	Y	Y	N
Hamilton Filter	N	N	N	Y
Time FE	Y	Y	Y	Y
State-Industry FE	Y	Y	Y	Y

Table 5: Estimation Results: Levels

Notes: Standard errors in parenthesis, clustered at the industry level. * 0.10 ** 0.05 *** 0.01

Figures

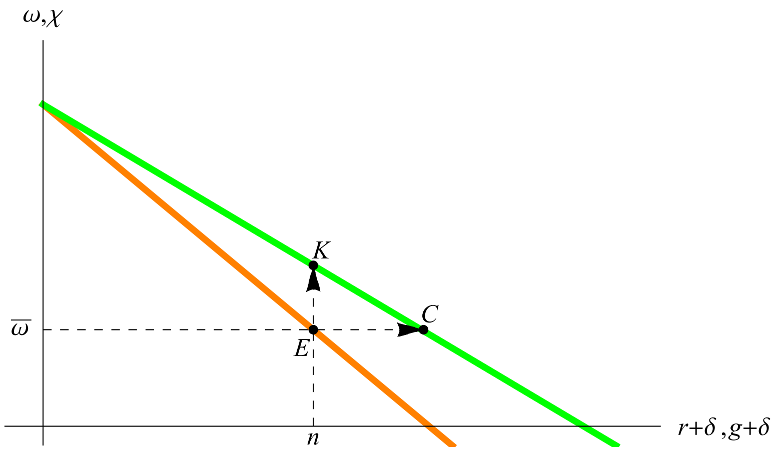


Figure 1: Growth-distribution schedules corresponding to lower (orange) and higher (green) utilization rates, and different model closures.

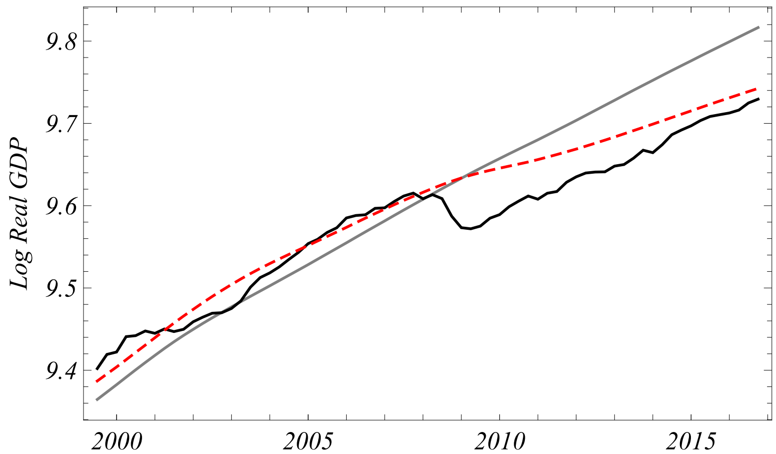


Figure 2: Real GDP compared with CBO estimates of potential GDP in 2007 (gray) and 2017 (red).

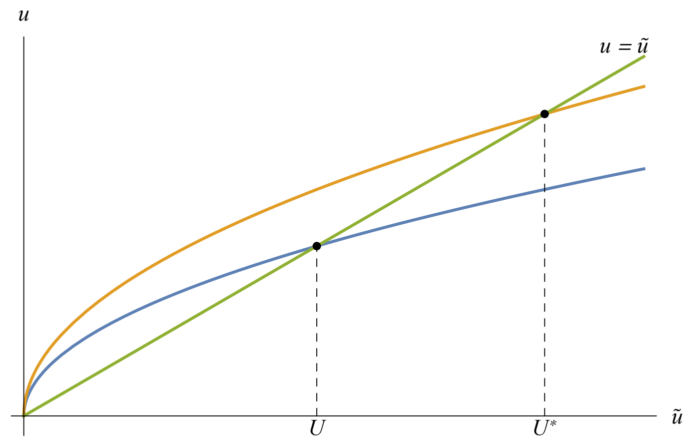


Figure 3: Equilibrium *vs.* socially-coordinated utilization rates.

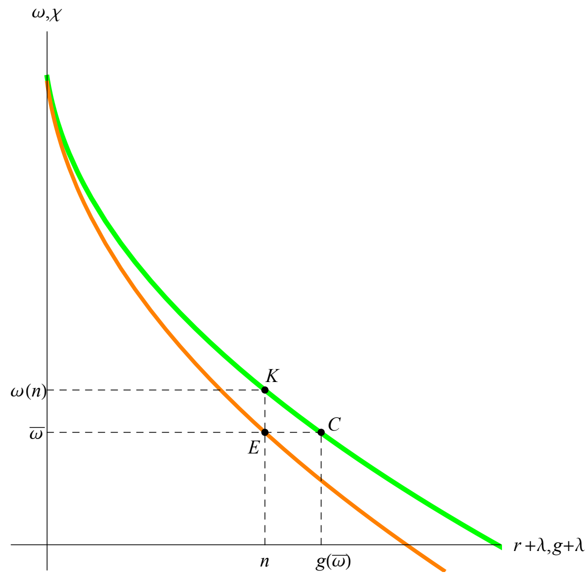
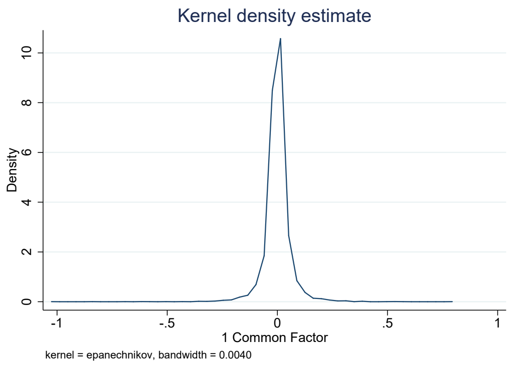
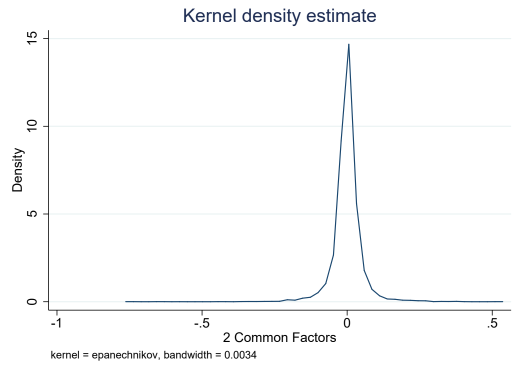


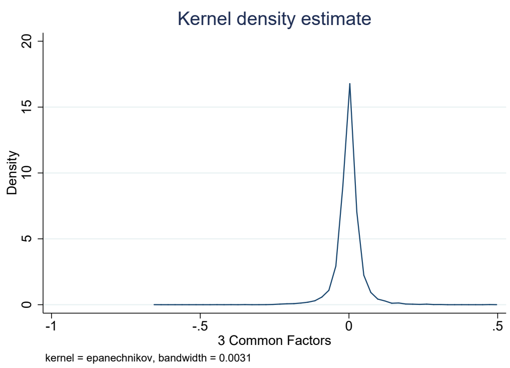
Figure 4: Equilibrium *vs*. socially-coordinated GD schedules, and the possibility of bargained Pareto-improvements (segment *KC*).



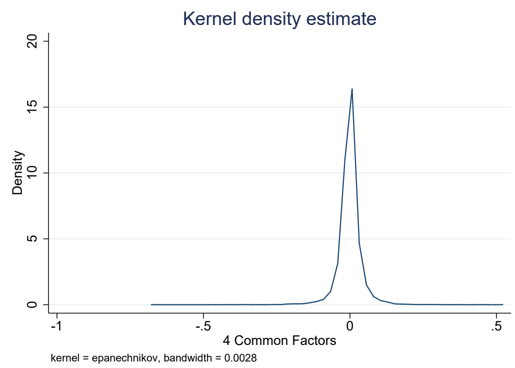
(a) One Common Factor



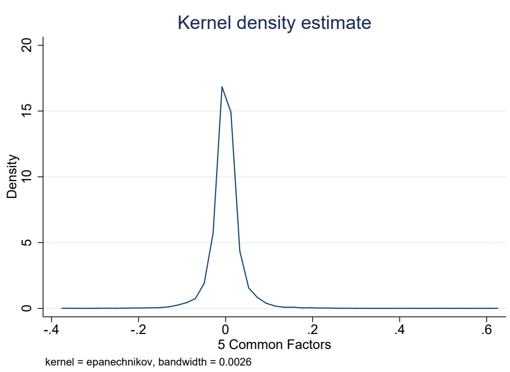
(b) Two Common Factors



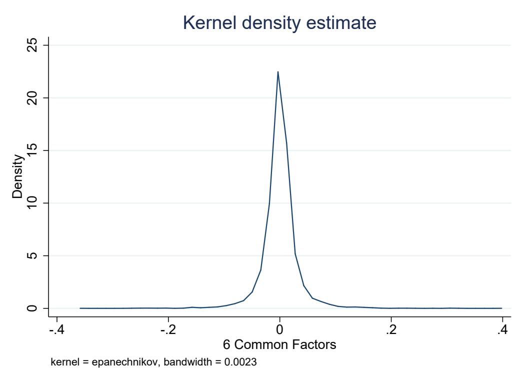
(c) Three Common Factors



(d) Four Common Factors

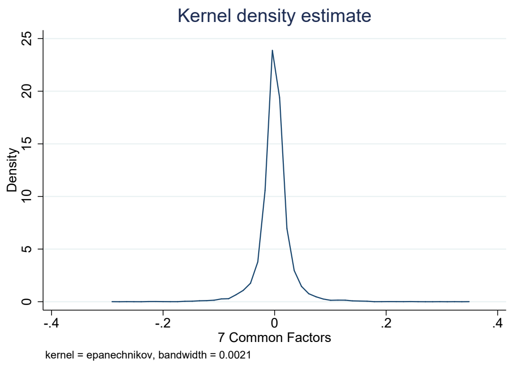


(e) Five Common Factors

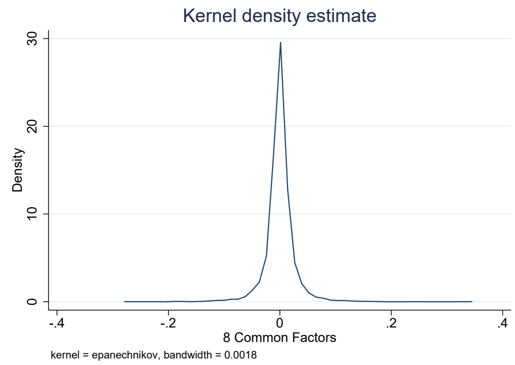


(f) Six Common Factors

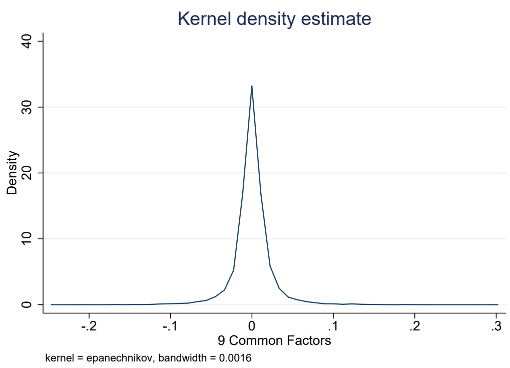
Figure 5: Residual Density Plots for Common Factors (1/2)



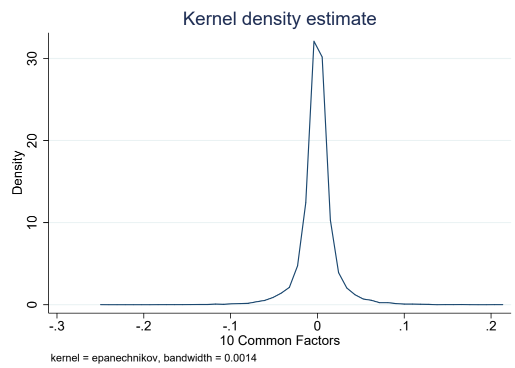
(a) Seven Common Factors



(b) Eight Common Factors



(c) Nine Common Factors



(d) Ten Common Factors

Figure 6: Residual Density Plots for Common Factors (2/2)

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