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Contact Intensity, Unemployment and Finite Change - The Case of Entertainment Sector under Pandemic: A General Equilibrium Approach

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CONTACT INTENSITY, UNEMPLOYMENT AND FINITE CHANGE-THE CASE OF ENTERTAINMENT SECTOR UNDER PANDEMIC: A GENERAL EQUILIBRIUM APPROACH

Abstract

This paper explores the short run, medium run and long run impact of pandemic on the contact intensive entertainment industry in terms of a simple general equilibrium model that can accommodate for unemployment and underemployment. Finite change as a response to large shocks may lead to vanishing occupations in this industry, even when pandemic is over and leads to underemployment. Pandemic tends to eliminate fixed wage contracts in this sector for its survival, but over the longer run affects fundamental occupational choice in a society.

JEL Classification: F22, J31, O15

Keywords: Wage gap, Covid-19, Entertainment, Contact-intensive, Finite Change, General Equilibrium.

Contact Intensity, Unemployment and Finite Change -The Case of Entertainment Sector under Pandemic A General Equilibrium Approach

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ABSTRACT

Abstract

This paper explores the short run, medium run and long run impact of pandemic on the contact intensive entertainment industry in terms of a simple general equilibrium model that can accommodate for unemployment and underemployment. Finite change as a response to large shocks may lead to vanishing occupations in this industry, even when pandemic is over and leads to underemployment. Pandemic tends to eliminate fixed wage contracts in this sector for its survival, but over the longer run affects fundamental occupational choice in a society.

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1. Introduction and Motivation

The pandemic has jolted the world economy severely, with disruptions on both the demand and the supply side. The trade-offs triggered by the pandemic—health versus wealth, labor-elimination versus labor-saving technology, online (virtual) vis-à-vis off-line activities, etc.—are harsh. It has affected trade, employment, human capital, and overall economic performance across nations. For obvious reasons, nothing has attracted more attention than Covid-19 and its ripple effects since 2020 till now. However, within a nation across different sub-sectors the

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impacts are diverse. The specific aspect of the pandemic that is relevant for sectoral performance is the riskiness or uncertainty of contagion with apprehension of spread of disease due to possibilities of close contact among the customers (demanders/buyers), firms or service providers (organizing production combining labor, technology, and machines) and between different groups of people. As for organizing production, economic activities involve employment of labors of different types in different sectors, and their interaction, “contact-intensity (CI)” of sectors is a crucial factor for differences in impacts across sectors. Sectors requiring ‘teamwork’ or ‘customer-proximity’ suffer most (Koren and Peto 2020). Some sectors contract more than the others, while switching to automation to reduce human interaction or replacing unskilled can displace workers. All these depend on the nature of the industries, for example, broadly speaking, whether it is agriculture, manufacturing and services, as well as sub-sectors under these broad classifications.

However, thanks to digitization led by ICT and sprawling of virtual or online trade (see Marjit, Mandal and Nakanishi 2020 and Marjit, Das, and Mandal 2022), intensity of contact is much less for organizing production remotely. As sectoral adjustments take different length of run depending on the scope of exposure due to physical proximity, and contact-intensive nature of the occupations, we will consider a core model and then, outline possible extensions to capture medium and long run impact evaluation of pandemic shocks. Typically, we start with a relatively short or medium run where specificity of factors matter significantly before showing the case of long run where skill switching could occur.² Our focus is on the cultural or entertainment sector as this sector suffered from major setback due to Coronavirus abatement strategy emphasizing on social distancing.

In this paper, by employing 3-sectors, 4-factors general equilibrium model (Jones 1965, 1971, Marjit and Jones 1990, Jones 1971, Samuelson 1971-to name some of them), we highlight on how CI could affect employment, output, and wage-differentials across skill types of workers. As background and motivation, Section 2 offers some empirical studies across developed and developing world as a background literature. Section 3 develops a core model serving as benchmark. Section 4 offers analysis of pandemic-induced shocks and consequent final changes

² It is quite realistic that a doctor or surgeon or a professor (in any discipline) with musical talent or artistic acumen could choose the medical profession or the role of an educator as primary source of earning (occupation) while the other extra-mural talent provides mental solace to supplement the first activity as returns to skill. Role of the creative or cultural sector for advancing development and generating cultural wealth for human development is discussed recently by Kabanda (2018). However, investing time for her/his to switch will take some time—not substantial though—to make the first profession secondary, while s/he makes transition between two different sorts of skills. On the other hand, for a musician or theatrical personality with no formal training in say, profession like surgery or computer programming, s/he cannot do so easily. However, s/he can switch to different occupation—as and when the crisis hits her/his profession devastatingly—that is, imperfect but closely substitutable profession such as, learning some ‘mechanical’ skills to run on a virtual or online platform. Such an *inter-occupational switching* takes much longer time and eventually could emerge under dire necessity for survival. For extension, we could outline such case later in extension where same skill could ‘work’ in both the sectors such as, online or performing arts.

in the entertainment sector, affecting employment of workers engaged in that sector. Section 5 concludes.

2. Pandemic-led impact on Creative Sectors: Current Literature and Empirical Facts

Covid-19 has opened Pandora's Box by exposing us with numerous trade-offs affecting socio-economic and political landscapes. Earle (2020a &b) has been an exhaustive study that came out readily covering issues such as effects of Coronavirus on financial markets, mortality and inequality, human development, medical care, trade war, limits of monetary and fiscal policy, etc, as well as paths to economic recovery. McCann and Vorley (2021) is another important volume exploring the impact of uncertainty related to Covid-19 and its impact on firms' productivity, skill development, shift to online consumption via behavioral changes, etc.

As a result, with the spread of the contagion after the initial outbreak of the contagion, several measures were adopted as part of containment strategy. Lockdowns (total or partial), Social distancing, and adopting hygiene and health standards are imperative adopted all over the world with more or less similar policy regulation in practice. This has caused repercussions across different sectors. Most contact-intensive sectors are agriculture (10%), construction (87%), services (80%), manufacturing (63%), electricity (47%), and mining (46%).³ Recent Economic times report surveys that without vaccine suboptimal levels of operation of some sectors are due to 'consumer wariness' (due to risk of infection and voluntary spatial/social distancing) where contact-intensity (CI) of final demand is high like in airports, cinema, opera, entertainment, and shopping malls. CI of services differs across groups with high CI of final demand in trade, tourism, etc. For manufacturing, on the contrary, has low CI of final demand (6%), but CI of supply chain is high for labor-intensive production process such as textile manufacturing, food, etc. As per the recent Economic Survey, contact-intensive service sub-sectors—tourism, aviation, hospitality, trade, hotels, transport, communication and services contracted by 31.5% in 2020-21, with overall contraction by 16% only in the first-half of 2020-21. It is projected that gross value-added (GVA) of service sector will contract by 8.8% in 2020-21.⁴ Nam and Lee (2021) in the South Korean context that compared to the Financial crisis in 2008, Covid-19 decreased employment rate by 0.82 percentage point and increased unemployment rate by 0.29 percentage point.

Whether be it developed or developing country, developing countries suffer more from lockdowns than the developed countries and with shares of 'informal sector' and SMES being 70% of total employment and 30% of GDP (Fairlie 2020).⁵ By constructing 'physical proximity intensity index' and 'occupational CI index', Famiglietti, Leibovici, and Santacreu (2020) has shown in the context of USA that non-essential CI-industries have suffered most from job losses.

³ <https://economictimes.indiatimes.com/markets/stocks/news/contact-intensity-score-shows-which-sectors-to-take-biggest-hit-from-here-on/articleshow/77871899.cms>

⁴ https://www.business-standard.com/article/primer-friendly-version?article_id=121012901523_1

⁵ <https://www.aier.org/article/why-government-lockdowns-mostly-harm-the-poor/>

Opera and entertainment is one such non-essential CI sector, and hence is expected to suffer from decline in activities or jobs, while supply-chain related health care, utilities, and food are CI, but essential, and going online or virtual trade does help these to flourish. Glocker and Piribauer (2021) has estimated output losses in a cross-country study of 130 nations due to contact-intensity of services and spatial distancing. Several studies have empirically documented heterogeneous effects of Covid on the labor market—employment, sectoral differences, and output. For example, Kugler et al. (IZA, June 2021), Koren and Peto (2021). Koren and Peto (2021) has shown that even with digitization or spread of ICT, some industries are totally paralyzed with non-pharmaceutical interventions. To quote them: *“employment losses have been largest in sectors that rely heavily on consumer contact and where the contacts dropped the most: retails, hotels, and restaurants, arts and entertainment and schools. Our results can help quantify the economic costs of social distancing. (pg. 1)”*. Barrero, Davis, and Bloom (2021a&b) finds that due to multiple waves 20% of work will be work-from-home (WFH) after the pandemic compared with 5 percent in the pre-pandemic period due mainly to ‘lingering concerns about crowds and contagion risks and a pandemic-driven surge in technological innovations that support WFH’. Consequences of such WFH by the privileged, professional high-skilled class as opposed to the underprivileged or informal, unskilled workers struggling for survival due to lack of work opportunities could lead to a different mode of inter-class dependence thanks to herd-immunity by the latter (Marjit and Das 2022). As more WFH will stay, and as more automation is adopted apprehension of rise in inequality with displacement of low-skilled workers without alternative formal employment is a major concern (Sedik and Yoo 2021, Maarjit and Das 2021).

Hu and Zhang (2021) used financial data to show in a cross-country study that firm performance suffered during 2020—2021 especially in countries with worse healthcare systems, and less sophisticated financial systems, and low quality institutions. In addition, high degree of uncertainty has stronger adverse effects on firms. Most importantly, the study finds that ‘devastating effects’ on business performance originates from both supply and demand sides. Due to the fear of the customers about the spread of the disease, the demand side impacts are more felt in the services and cultural sectors while bankruptcy and distress in organizing production affects SMES and corporate performance supply shocks come into force, thus, reinstating the role of ‘general equilibrium’ adjustments via Covid. Further, the role of ‘demand-deficient recession’ where overreaction of demand to supply shock is emphasized. In the context of Japan, Joji (2021) has also explored the role of preventive measures imposing constraints on social and economic activities causing ‘demand slump’ as well as drop in exports and production thanks to ‘precipitous’ decline of economic activities, contraction of the world economy and trade. Das, Bisai and Ghosh (2021) has analyzed the impact of pandemic on inequality in general for 1995 to 2017 for 70 countries to highlight how Covid could trigger such impacts. Court et al. (2021) has also analyzed the case of ‘dampened economic activity’ due to preventive measures and consumer wariness on ‘non-essential’ sectors as well as ‘decreased

production' affecting other industries. In fact, they show that *'for each 1% decline in the demand for non-essential products, the GINI index across nations is expected to rise by 0.3%. That is, global inequality is likely to rise, contradicting some earlier findings. Finally, we show that economies with less-diverse sets of industries are more vulnerable to such global shocks.'*

Other studies that discuss this kind of adverse effects on sectors and their adjustability for survival are Sheridan et al. (2021), Hou et al. (2021), Bartik et al. (2021), Hardin (2021). Adbi, Chatterjee and Mishra (2022) has shown how an unanticipated global shock like pandemic can change the business environment faced by the foreign multinational firms as well as the domestic rival firms based on inadequate industry or health infrastructure, heterogeneity in economic resources, and political alignment. Joyce and Xu (2020) is another study highlighting the exposure of workers and Covid-19 led lockdowns. Jayaram et al. (2020) presents the cases in the African context showing the lives versus livelihood trade-offs. In an important study, Buers et al. (2020) considered a model with labor market and financial market frictions to show that non-essential firms suffer most without government subsidies and/or, frictions in the labor market to revert to previous job. With permanent sectoral reallocation, the severity of recession is obvious.

From all these studies, it is clear that contact intensity—either from final demand side or from supply chains to organize production—is less where labor-intensity is less in production, and where remotely performable operation or activities have higher share in final output. In that sense, entertainment sector has high CI, while manufacturing has much less CI, and online sector has least CI. A general equilibrium framework is necessary to capture such aspects. With the onset of Covid-19 crisis, voluminous literatures have emerged dealing with many aspects. As per Conley and Johnson (2021), the dimension of such research is enormous with 142, 000 articles over a year and one article per 4 minutes. Most of these deal with causal relationships among factors with 'big data' and/or, econometric exercises. This empiricism is useful exercises exploring the interrelationships among economic variables as well as health-related factors providing rich arrays of information. Conley and Johnson (2021) urges for research going beyond the "causal revolution" to comprehend "generalizability" based on the findings in order to address 'longstanding questions in the social sciences'. Ours is an attempt to fill this gap so that any exogenous shock alike pandemic or unanticipated adversity can affect an endogenous system encompassing various economic activities.

However, to the best of our knowledge, providing a framework to theoretically analyze such evidences have not been attempted so far, and that could throw light on the ensuing impacts of Covid-led recessionary disruptions. Although Camera and Gioffre (2021) offered an analytical framework based on 'random matching', they explored the impact of lockdowns on contagion prevention and healthcare costs, and social welfare via income generation. Our value-addition lies in offering an economy-wide repercussions via interlinked endogenous system, and in what follows, we model such ripple effects of the pandemic.

3. Modeling Frameworks for Short and Long Run Impact Evaluation

A benchmark model is laid out in this section. This is the core of our analytical framework. Subsequently, by amending some assumptions we suggest in a more realistic fashion some closely related variant structures to capture some episodes of the pandemic-related adjustments. As the nature of production entails specific factor where different sectors employ workers with diverse skill sets, Heckscher-Ohlin-Samuelson (HOS, henceforth) production structure is inadequate to capture it. For example, the entertainment or the culture sector needs specific skills (opera singer, ballet dancer, or a theater personality needs skills which is not necessary to run an online or virtual trade requiring expertise in software or programming like engineers do). However, to handle multiple level of skills across laborers and multiple outputs we go beyond the standard HOS types to propose a mixed specific factor hybrid model a la Marjit (1990 & 2009), Jones and Marjit (1992 & 2009), Marjit and Das (2021), Marjit and Acharyya (2003), Jones (2019), Das et al. (2020), to name a few.

Typically, from the facts summarized in Sections 1 and 2, we could envisage the followings:

- (i) contact-intensive industries shrink due to restrictions on physical mobility and hence, contact-intensity of production/supply chain disrupts activities;*
- (ii) contact-intensity of final demand causes entertainment industry to contract or vanish;*
- (iii) no adverse substantial changes (such as lack of demand) of activities in the sectors where e-commerce/e-business or online services expansion occurs, thanks to digitization, will flourish.*

All these will have repercussions in the labor market creating unemployment and/or, underemployment, which is the focus of the present analysis.

3.1 CORE MODEL

Consider three sectors, viz., Virtual or online sector (X), Entertainment sector (Y), and a manufacturing sector (Z). X uses specific types of software experts or those with competence in programming (S_x) along with capital (K) while cultural sector Y needs experts with skills in performing arts or creativity of different sorts (S_y) along with capital. For Z-sector, we consider unskilled or semi-skilled workers (L) who are engaged in producing machine tools in the MSME sectors characterized by medium or low-tech sophistication along with capital. However, this sector—under the current scenario—might face the threat of automation displacing the low-skilled. Capital (K) is mobile across X, Y, and Z while S_x , S_y , and L are specific factors, without intersectoral mobility in the medium or short-run.⁶ Thus, the production setup is:

⁶ Assumption of malleability of 'K' across X, Y and Z is driven by simplicity because our primary objective is to model the impact on the labor markets. Not only that, 'K' can also be considered as 'financial capital' providing funds to run these sectors (see Marjit and Das 2021). Of course, realistically nature of physical capital used in different sectors can be different. Also, we can think of 'K' as ICT capital or digital capital enabling all kinds of activities.

$$X = X(S_X, K)$$

$$Y = Y(S_Y, K)$$

$$Z = Z(L, K)$$

Assume a small open economy (SOE)—a price-taker in the world market—with perfectly competitive markets. Technology is neo-classical with CRS and diminishing marginal productivity (DMR) to factor inputs. Given Z, X and Y are readily identified as 2-sector-3-factor textbook style specific factor model (Jones 1971, Caves and Jones, 2002, Krugman, Melitz and Obstfeld 2019). One pertinent feature of this type of structure is that each pair of sectors represents a 2-sectors \times 3-sectors specific factor (SF) subsystem (SFS). Following notations are used to describe model:

X: Skilled online sector

Y: Skilled entertainment sector

Z: manufacturing or MSME sector.

P_j : exogenously given prices for j^{th} final good, $\forall j \in \{X, Y, Z\}$

W : Unskilled labor's wage in the host country

W_X, W_Y : Skilled labor's wage in the host in X, and Y-sector. Assume originally, $W_X > W, W_Y > W$.⁷

r : Return to homogeneous capital.

a_i^j = i^{th} input required to produce 1 unit of j^{th} good, $i = L, S_X, S_Y, K$; and $j \in \{X, Y, Z\}$.

$\theta_{lj} = w_l a_l^j / P_j$ is the distributive share of l^{th} labor-types in the production of j , $\forall l \in \{S_X, S_Y, L\}$;

$\theta_{kj} = r_k a_k^j / P_j$ is the distributive share of owner of capital K ;

$\lambda_{ij} = \frac{a_i^j N_j}{f_i}$ = j^{th} commodity's input share in i^{th} factor's endowment, where N is generic output and f is generic endowment.

$\bar{K}, \bar{S}_X, \bar{L}$, and \bar{S}_Y are given factor endowments of respective primary inputs.

" \wedge " = proportional changes for variable, say V , such that generically $\hat{V} = \frac{dV}{V}$. Full employment ensures:

$$a_{SX} X = \bar{S}_X \quad (1)$$

$$a_{SY} Y = \bar{S}_Y \quad (2)$$

$$a_{LZ} Z = \bar{L} \quad (3)$$

$$a_{KX} X + a_{KY} Y + a_{KZ} Z = \bar{K} \quad (4)$$

⁷ Skilled labor attracts considerable higher wage than their unskilled counterpart, although levels are *lower than* the rich nations. Skill-biased trade or technical change are several reasons that explain wage gaps. Here nature of skills differs across sectors and with social distancing or different types of physical proximity, skilled occupations also face imminent dangers in sectors like opera, group theater, etc. where chances of spread loom large. In case of manufacturing, such barriers exist too.

From (4), rewrite: $K_X + K_Y + K_Z = \bar{K}$ and hence, we write:

$$K_X + K_Y = \bar{K} - K_Z \quad (4a)$$

Competitive equilibrium with zero pure profit condition implies that price equations are:

$$W_X a_{SX} + r a_{KX} = P_X \quad (5)$$

$$W_Y a_{SY} + r a_{KY} = P_Y \quad (6)$$

$$W a_{LZ} + r a_{KZ} = P_Z \quad (7)$$

3.2 EQUILIBRIUM AND COMPARATIVE STATICS

From (4), *given* S_X and S_Y for the specific factor sub-system (i.e., X and Y), if K_Z rises (or falls), $K_X + K_Y$ falls (or, rises) from the supply side and vice versa. Correspondingly, ' r ' rises (or, falls). Thus, in the r - K_Z space, we trace a positively sloped curve (AA) (see Figure 1). However, in Z, *given* L, K_Z rises/ falls, means r falls/ rises. So, in the r - K_Z space we get ' BB ' with downward slope. Figure 1 determines K_Z and ' r '. Also, 7 equations determine 7 variables, viz., W_X , W_Y , W , r ; and Outputs (X, Y, and Z). $a_{ij}(W_X, W_Y, W, r)$'s are determined endogenously via CRS. That describes the general equilibrium (GE) system.

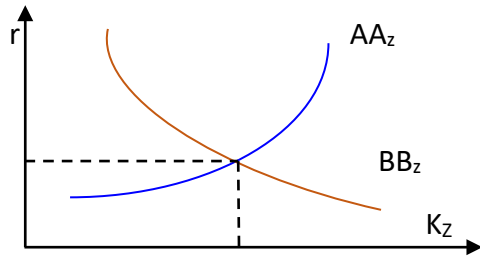


Figure 1. Determination of r - K_Z

Consider ex post changes due to social distancing and lockdown scenarios, and their GE effects. The online sector (X) is the *numeraire* sector. We consider proportional changes for the equation system (1) — (7), and employing envelope condition (Jones (1965, 1971)), to derive:

$$\theta_{SX} \widehat{W}_X + \theta_{KX} \hat{r} = \widehat{P}_X = 0 \quad (8)$$

$$\theta_{SY} \widehat{W}_Y + \theta_{KY} \hat{r} = \widehat{P}_Y \quad (9)$$

$$\theta_{LZ} \widehat{W} + \theta_{KZ} \hat{r} = \widehat{P}_Z \quad (10)$$

$$\text{where } \theta_{SX} + \theta_{KX} = 1, \theta_{SY} + \theta_{KY} = 1, \theta_{LZ} + \theta_{KZ} = 1 \quad (11)$$

3.2.1 Pandemic-led Adverse Effects on Entertainment Sector: fall in P_Y

Suppose ' $(1-q)$ ' is the probability that a sector is not affected by the pandemic, $q \in [0, 1]$. In this case, as the probability of exposure is higher due to nature of contact-intensiveness, the higher is the chances of output loss as $q \rightarrow 1$ (equivalently, $(1-q) \rightarrow 0$). These are non-essential goods where income elasticity of demand (like luxury goods) is high. Loss of income due to sluggish

economic activities will dampen demand too, causing decline in prices for show/performances. Demand will shrink and expenditure will fall, even with lower prices (even if price falls for Y-sector, demand inelastic). Ceteris paribus, as P_Y falls, Y-sector contracts with fall in 'K_Y'. Given the *same* K_Z, this adverse price shock (with $P_X = 1$ as numeraire) will cause 'r' to fall and 'AA_Z' will shift right downward (Figure 2). 'K' released from 'Y' sector will move to K_X and K_Z.

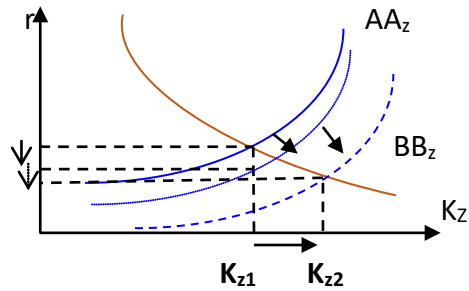


Figure 2. Shift of AA curve in r-K_Z space

As 'K' moves into X and Z, marginal productivity (MP) of labor types in X and Z rises. Now with $\widehat{P}_X = 0, \widehat{P}_Z = 0$ as 'r' falls, W_X and W rises while W_Y falls. Thus, three possibilities might emerge as below: (a) $\frac{W_X}{W_Y}$ rises implying changes in inequality in the skilled labor types itself so that intra-skill wage inequality increases depending on respective skill-shares in production; (b) as W_X and W rises, depending on K-intensity of these sectors $W_X \geq$, or $\leq W$; (c) $\frac{W_Y}{W}$ falls, improving wage inequality between entertainment and casual sectors. However, if Y is S_Y intensive, via Stolper-Samuelson effect W_Y falls by more.⁸ As $\widehat{Y} < 0, \widehat{r} < 0 \Rightarrow \widehat{W}_X > 0, \widehat{W}_Y < 0$

For SF subsystem comprising of X-Y sectors, it is straightforward to write a la Jones (1971),

$\widehat{W}_Y < \widehat{P}_Y < \widehat{r} < 0 < \widehat{P}_X = 0 < \widehat{W}_X$. Thus, skilled performers in the entertainment sectors are worse off while those in the online sectors with software expertise are better off. For capital owners suffering from decline in price fall are caught in the middle with its real return increasing in terms of the skilled labors in the Y-sector, while suffering compared to those in the online.

3.2.2 Adverse impacts on Casual/Informal Sector: Ceteris paribus fall in P_Z

Here we consider fall in P_Z , while others remain unchanged. Given L, S_X, and S_Y, output shrinks in this sector and 'W' falls (if Z is L-intensive, it will have more pronounced effect). As K_Z falls, 'r' will fall and (K_X+K_Y) will rise. BB_Z curve will shift left downward (see Figure 3).

⁸ Here if P_Y falls, ceteris paribus, we can show that wage inequality aggravates between X-Z sectors and X-Y sectors, while for the performance industry, it could suffer-- due to abysmally low demand—as workers are chucked off, and hence unemployment generates so that even the unskilled workers gain at the expense of those in the entertainment sector. See Marjit and Das (2021, Cesifo).

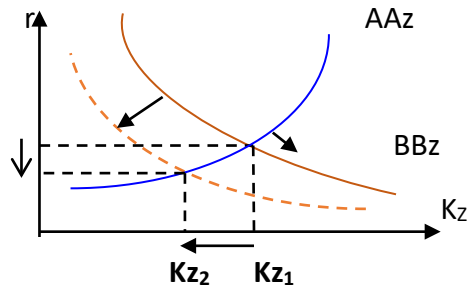


Figure 3. Shift of BB curve in r-Kz space

These changes result in rise in MPs of S_y and S_x , and hence translating into rise in W_y and W_x . Depending on share of capital in cost, W_x will rise more than W_y and $\frac{W_x}{W}$, $\frac{W_y}{W}$ both rises. This will aggravate wage inequality between skilled-unskilled workers. In this case, unskilled workers are worst affected while both the skilled occupations gain, with more pronounced gainful effects in the skilled sector with higher capital intensity. In both of these cases, here we get interesting impacts with *two-pronged nature* of wage inequality, viz., between skilled sectors itself as well as between skilled and unskilled. In the context of our chapter, interesting case is the impacts while both Y and Z suffer due to pandemic led policy of social distancing.

3.2.3 Joint adverse impact of $\hat{P}_Y < 0$, $\hat{P}_Z < 0$

Here we consider with $q \rightarrow 1$, $\hat{P}_Y < 0$, $\hat{P}_Z < 0$ conjointly. Definitely, following the preceding discussion both AA_z and BB_z will shift downward. However, impacts on reallocation of 'K' to other sectors following decline in prices will depend on relative position or relative shifts of the AA-BB curves ex post in the r-Kz space. Accordingly, three cases are plausible, viz., (a) K_z rises, (b) K_z falls, (c) K_z does not change. Here we consider Eqs. (8a), (9a) and (10b), via shifts of AA_z and BB_z , 'r' falls, triggering alterations in K_z vis-a-vis W/r impacts via AA-BB shifts (see Figure 4 below). Let initially AA-BB cross each other at (K_{z1}, r_1) . If downward shifts happen in such a way so that AA_{z1} and BB_{z1} intersect that K_z remains unaltered ($\Delta K_z = 0$), then $r_3 < r_1$. Suppose now that the downward shift AA_{z2} is much more than previous case, while BB_{z1} remains the same ex post, then r falls by more ($r_2 < r_3 < r_1$), and $\Delta K_z > 0$. Now, think about shifts in BB_{z2} being more pronounced than BB_{z1} so that new BB_{z2} cuts either AA_{z1} or, AA_{z2} resulting in $\Delta K_z < 0$. Hence, depending on *relative position* due to shifts in the wake of fall in P_Y and P_Z , $\Delta K_z \leq 0, \Delta K_z \geq 0$ and extent of $\hat{r} < 0$ occurs, and how much K_z moves matter.

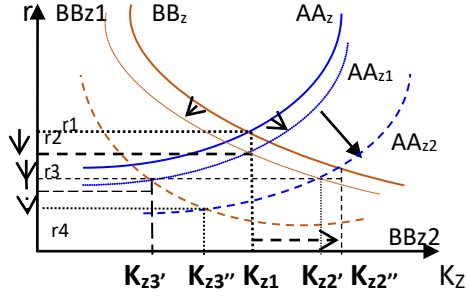


Figure 4. Joint shift of AA-BB curve in r - K_z space

However, movements in 'K' across sectors trigger changes in MP of labor types and hence, changes in respective wages of skill-types vis-à-vis the unskilled ones.

Proposition 1: Given $\widehat{P}_X = 0$, with $q \rightarrow 1$, $\widehat{P}_Y < 0$, $\widehat{P}_Z < 0$, it must hold that:

$\left(\frac{\widehat{W}_X}{\widehat{W}_Y}\right) > 0$, but $\left(\frac{\widehat{W}_X}{\widehat{W}}\right)$ and $\left(\frac{\widehat{W}_Y}{\widehat{W}}\right)$ are ambiguous depending on cost-share of capital in the

respective concerned sectors; however, wage inequality between X-Y, X-Z, and Y-Z sectors would worsen iff $\theta_{KX} > \theta_{KY}$ and $\theta_{KY} > \theta_{KZ}$.

Proof: Consider first $\widehat{P}_Y < 0 = \widehat{P}_X$, the standard result via SF-subsystem (SFS) implies (Jones 1971 and Samuelson 1971): $\widehat{W}_Y < \widehat{P}_Y < \widehat{P}_Z < \widehat{r} < 0 < \widehat{W}_X$. Similarly for $\widehat{P}_Z < 0 = \widehat{P}_X$ case, $\widehat{W} < \widehat{P}_Z < \widehat{r} < 0 < \widehat{W}_X$. Thus, movements in real wages for $\widehat{W}_X - \widehat{W}_Y, \widehat{W}_X - \widehat{W}, \widehat{W}_Y - \widehat{W}$ occur.

- If (i) $\widehat{P}_Y < \widehat{P}_Z < 0 = \widehat{P}_X \Rightarrow \widehat{W}_Y < \widehat{P}_Y < \widehat{P}_Z < \widehat{r} < 0 < \widehat{W} < \widehat{W}_X$. Here (W/r) , (W_X/W_Y) , (W_X/W) rise along with rise in (W/W_Y) .
- On the contrary, if (ii) $\widehat{P}_Z < \widehat{P}_Y < 0 = \widehat{P}_X \Rightarrow \widehat{W} < \widehat{P}_Z < \widehat{P}_Y < \widehat{r} < 0 < \widehat{W}_Y < \widehat{W}_X$. Here (W/r) falls, but (W_X/W_Y) , (W_X/W) rise along with rise in (W_Y/W) .

Now, from figure 4 above, in the presence of joint effect, *movements of 'K' across sectors*—from Y and/or, Z sectors to X—depends on the extent of relative position (or shifts) of AA_Z - BB_Z .

In case of (i), we see $\widehat{P}_Y < \widehat{P}_Z < 0 = \widehat{P}_X \Rightarrow \widehat{Y} < 0, \widehat{Z} < 0, \Delta K_Y < 0 \Rightarrow \Delta K_Z > 0, \Delta K_X \geq 0$ because AA_Z shifts by more than BB_Z (see Figure 3). Thus, $\widehat{W} > \widehat{r}, \widehat{W}_X > \widehat{W}_Y, \widehat{W} > \widehat{W}_Y, \widehat{W}_X > \widehat{W}$. In case of (ii), we see $\widehat{P}_Z < \widehat{P}_Y < 0 = \widehat{P}_X \Rightarrow \widehat{Y} < 0, \widehat{Z} < 0, \Delta K_Y < 0 \Rightarrow \Delta K_Z < 0, \Delta K_X \geq 0$ as BB_Z shifts down by more than AA_Z (see Figure 4). Thus, $\widehat{W} < \widehat{r}, \widehat{W}_X > \widehat{W}_Y, \widehat{W}_Y > \widehat{W}, \widehat{W}_X > \widehat{W}$.

However, if $\widehat{P}_Z = \widehat{P}_Y < 0 = \widehat{P}_X$, then AA_Z and BB_Z shifts *equiproportionately* downward (Figure 4)

so that, $\Delta K_Z = 0, \Delta K_X \geq 0$. Here $\widehat{\left(\frac{W}{r}\right)} = 0$ and $\widehat{\left(\frac{W_X}{W_Y}\right)} > 0, \widehat{\left(\frac{W}{W_Y}\right)} > 0$.

Overall, $\widehat{P}_Y < 0, \widehat{P}_Z < 0 \Rightarrow \widehat{Y} < 0, \widehat{Z} < 0$ and relative decline in their prices determine the mobility of K to Z vis-à-vis X sectors and the extent of inter-sectoral reallocation. Previously, we saw that if $\theta_{KX} > \theta_{KY}, \widehat{W}_X > \widehat{W}_Y > \widehat{W}$ when $\widehat{P}_Z < 0$ and

if $\theta_{KX} > \theta_{KZ}, \widehat{W}_X > \widehat{W}_Y, \widehat{W}_X > \widehat{W} \Rightarrow \widehat{W}_X > \widehat{W} > \widehat{W}_Y$ when $\widehat{P}_Y < 0$

Now from (9a), (10a), on simplification, we can write:

$$\widehat{W}_Y - \widehat{W} = \left(\widehat{P}_Y / \theta_{SY} - \widehat{P}_Z / \theta_{LZ} \right) + \hat{r} \left(\frac{\theta_{KZ} - \theta_{KY}}{\theta_{SY} \theta_{LZ}} \right) \quad (11a)$$

If $\theta_{KZ} < \theta_{KY}$, $\hat{r} \left(\frac{\theta_{KZ} - \theta_{KY}}{\theta_{SY} \theta_{LZ}} \right) > 0$. Hence, $\widehat{W}_Y \geq \widehat{W}$ iff $\widehat{P}_Y / \theta_{SY} \geq \widehat{P}_Z / \theta_{LZ} \Rightarrow \frac{\widehat{P}_Y}{\widehat{P}_Z} \geq \frac{\theta_{SY}}{\theta_{LZ}}$ and vice versa.

Suppose $\frac{\widehat{P}_Y}{\widehat{P}_Z} > 1$ or, < 1 , accordingly, $\widehat{W}_Y \geq \widehat{W}$ or, $\widehat{W}_Y \leq \widehat{W}$ iff $1 \geq \frac{\theta_{SY}}{\theta_{LZ}} \Rightarrow \theta_{LZ} \geq \theta_{SY} \Rightarrow \theta_{KZ} \leq \theta_{KY}$.

$$\text{Similarly, using (8) and (9), } \widehat{W}_X - \widehat{W} = \left(-\widehat{P}_Z / \theta_{LZ} \right) + \hat{r} \left(\frac{\theta_{KZ} - \theta_{KX}}{\theta_{SX} \theta_{LZ}} \right) \quad (12)$$

As $\widehat{P}_Z < 0$, $\theta_{SX} \theta_{LZ} > 0$, given $\hat{r} < 0$, $\widehat{W}_X > \widehat{W}$ iff $\theta_{KZ} < \theta_{KX}$. Combining these two conditions, we can write: $\widehat{W}_X > \widehat{W}_Y$ iff $\theta_{KX} > \theta_{KY}$ and $\widehat{W}_Y \geq \widehat{W}$ iff $\theta_{KY} > \theta_{KZ} \Rightarrow \widehat{W}_X > \widehat{W}_Y > \widehat{W}$ iff $\theta_{KX} > \theta_{KY} > \theta_{KZ}$.

Corollary 1: Given $\widehat{P}_X = 0, \widehat{P}_Y = 0$, with $q \rightarrow 1$, $\widehat{P}_Z < 0$, it must hold that:

$$\widehat{\left(\frac{W_X}{W_Y}\right)} > 0, \widehat{\left(\frac{W_X}{W}\right)} > 0, \widehat{\left(\frac{W_Y}{W}\right)} > 0. \text{ Skill-unskilled wage gap rises; however, wage inequality}$$

between X-Y sectors would worsen iff $\theta_{KX} > \theta_{KY}$. See Appendix for Proof.

Inequality is most likely to go up against the Entertainment industry's skilled performers. Unskilled or semi-skilled workers—although suffering from absolute decline in wage—are relatively better off compared to the skilled professionals in the entertainment activities, unless automation or digitization displaces them or eliminates their occupation. The core model serves as a useful benchmark to compare and contrast *how different less stark assumptions about mobility of labor types (and capital) might alter the consequences of the pandemic*. Then, different scenarios could evolve with gradual elapse of time when—depending on the movements of 'displaced' workers and capital—there will be transitional phases during which factor returns will also change. Following section captures such scenarios.

4. Variants of the Rudimentary Model

4.1 Very Short Run: Immobility of 'K'

For the immediate impact, we need to consider 'very short-run', which is different from the rudimentary model with specific skills but mobile capital. In the very short run, for capital it is too short to move across the sectors so that 'K' is *stuck* and hence, three sectors will have three different rate of returns, say, $r_x \neq r_y \neq r_z$. Also, $\overline{W}_x, \overline{W}_y$ are fixed contractually. Now, given specific skills with expertise are necessary to be absorbed in the X and Y sectors, they can—under dire necessity or with nothing to survive—move to the casual sector Z, while the unskilled or casual workers with no competence or innate talent or adequate skills to perform works in X or Y sector cannot move. Hence, there is *rigid upward mobility* (taking far longer time or impossible) of 'L' while S_x and S_y have *more downward mobility* because they can do the work in Z sector requiring no special talent to be trained. This makes possible that S_x and S_y could move to Z where 'W' is flexible unlike in X and Y sector with fixed wages to the skilled. In this scenario, we could get *disguised* unemployment in Z-sector where unemployed skilled workers mostly from Y-sector crowd along with the existing worker ('L') to push 'W' further down. If for some reason W_x and W_y decline so much that 'W' exceeds them, this downward mobility could also happen. Now the model with the following variations is written as:

$$\overline{S}_x - a_{sx} X = SU_x \quad (1a)$$

$$\overline{S}_y - a_{sy} Y = SU_y \quad (2a)$$

$$L = a_{LZ} Z = \overline{L} \quad (3a)$$

$$a_{KX} \cdot X + a_{KY} \cdot Y + a_{KZ} \cdot Z = \overline{K} \quad (4)$$

As before: $K_x + K_z = \overline{K} - K_y \quad (4b)$

Now, competitive equilibrium with zero pure profit condition implies that ($P=AC$):

$$\overline{W}_x a_{sx} + r_x a_{KX} = 1 \quad (13)$$

$$r_y a_{KY} = P_y - \overline{W}_y a_{sY} \quad (14)$$

$$W a_{LZ} = P_z - r_z a_{KZ} \quad (15)$$

As K_x and K_y are stuck, with fixed $\overline{W}_x, \overline{W}_y$ we will have $S_x < \overline{S}_x, S_y < \overline{S}_y$ causing unemployment in both X- and Y-sectors (SU_x, SU_y). 7 variables: W, r_x, r_y, r_z and outputs (X, Y , and Z) are determined via 7 equations (13)—(15) and (1a)—(4). r_x is determined from (13) and r_y from (14). Given a_{ij} 's, from (14), if P_y falls, r_y will fall given \overline{W}_y and from (15), given r_z , if P_z falls, W will decline. As 'W' is flex, given P_z , r_z will determined as residual.

With $\widehat{P}_y < 0, \widehat{P}_x = 0, \widehat{P}_z = 0$, r_y will fall. As 'K' is stuck, $\widehat{Y} < 0$ causes S_y to be chucked off, moving to Z-sector (not to X as latent skills cannot be instantaneously adjusted or transformed into productive employment at the same level of efficiency alike S_x with longer years of experience). Consequently, unemployment of S_y (SU_y) will rise, but that of S_x (SU_x) will remain

the same as $\widehat{P}_x = \widehat{r}_x = 0$. 'W' will have free fall with double whammy. Interesting thing is rising unemployment of S_y with decline in 'W' for the casual workers. However, if P_z falls W and r_z will fall proportionately, with no incentive for S_x and S_y to crowd in the Z-sector. SU_y and SU_x remain the same. *Ex post*, $\overline{r}_x > r_y (\widehat{P}_y < 0)$, $\overline{r}_x > r_z (\widehat{P}_z < 0)$. This leads to the following proposition:-

Proposition 2: *With K_x, K_y, K_z being stuck in very short run, and $\overline{W}_x, \overline{W}_y$ being contractually fixed unemployment in X and Y sectors will force S_x and S_y to move to Z-sector due to downward mobility so that: (i) $\widehat{W} < 0$; (ii) with $\widehat{P}_y < 0$, unemployment in Y will increase while unemployment in X is unaltered; (iii) with $\widehat{P}_z < 0$, existing unemployment in S_x and S_y prevails without alteration.*

Proof: see Appendix for formal proof.

4.2 Longer Run or Medium Run: intersectorally mobile 'K'.

In this case, as more time elapses after the pandemic hit hard the sector Y, with emergence of online commerce as dominant mode with the prospect of flourishing, suppose 'K' (construed as 'financial capital')⁹ is allowed to move across sectors. More leeway is gradually achieved over longer time-frame. However, depending on fixity of $\overline{W}_x, \overline{W}_y$, and changes of P_y vis-à-vis P_z , now the mobility of S_y will happen with the possibility of structural changes in the economy. With finite changes, possibility of vanishing Y-sector arises (Mandal and Marjit 2014; Dutta, Kar, and Marjit 2013; Beladi, Kar and Marjit 2012; Marjit and Kar 2013). Thus, we get:

Proposition 3: *With intersectoral mobility of 'K', two possibilities could arise when $\widehat{P}_y < 0$ and/or, $\widehat{P}_z < 0$: (i) iff W_x and W_y remain fixed Y-sector collapses with finite change so that only X and Z exist; (ii) if gradually W_x and W_y become unstuck, with flexibility of W_x, W_y and W the situation will converge to the benchmark model. Capital cost shares will determine the direction of wage inequality as in Propositions 1 and 2.*

Proof: See Appendix.

4.3 Longest Run: No 'Sy'

With the adverse impacts of pandemic looming large over the medium run, the possibilities of unemployment in Y sector casing displacement to Z-sector becomes graver. Hence, the profession loses charm or attraction. With threat of pandemic, there is lack of investments in 'creative sector' or creative talents in opera or ballet or drama with prospective rate of return being low. As people don't acquire these skills, $\overline{S}_y \rightarrow 0$, with no supply of skilled talent in the entertainment industry. Then with finite change Y will disappear while X and Z will survive. Then

⁹ K could be a 'wage fund' where financing occurs as if: $K = W_x S_x + W_y S_y + W_L$. See Marjit (2020) and Marjit and Das (2021). Here endowment effect could be analyzed. However, it's beyond the scope of this paper.

the new model will be a standard specific factor model with 2-sectors and 3 factors—specific factors skilled virtual experts (S), unskilled (L) and mobile ‘K’ as below:

$$W_s a_s + r a_{KX} = P_X \quad (16)$$

$$W a_{LZ} + r a_{KZ} = P_Z \quad (17)$$

$$a_s X = \bar{S} \quad (18)$$

$$a_L Z = \bar{L} \quad (19)$$

$$a_{KX} X + a_{KZ} Z = \bar{K} \quad (20)$$

Thus, we infer:

Proposition 4: With $\bar{S}_y \rightarrow 0, Y \rightarrow 0$ so that there will be finite change with vanishing Y-sector while X and Z will survive resulting in polarization with mostly online and some casual sectors. Like in standard specific factor model (Jones 1971, Samuelson 1971), inequality results are standard.

Proof: With $\hat{P}_Z < 0, \left(\frac{\widehat{W}_s}{\widehat{W}} \right) > 0, \widehat{W} < \hat{P}_Z < \hat{r} < \hat{P}_X = 0 < \widehat{W}_s$.¹⁰

5. Concluding Remarks:

Automation and labor-elimination or labor-displacement or labor-linking; Hybrid work for future where total work is a combination of off-line and online modes (e.g., 2 days offline-3 days online and vice versa or, say, 4 days lock down 3 days semi-lockdown or no lock down at all, giving much more freedom for organizing production so that some ailing or dying sectors could revive than with total shut down or, lock down.

Opera sector cannot be automated unlike the manufacturing sector where labor-saving technological change/innovation could reduce the demand for labor in that sector with further fall in wage. Although opera sector does not suffer from such potential effects, but demand from viewers fall and demand is inelastic, as price fall does not increase demand. Supply effect is much stronger as price crash will not stimulate demand due to fear of contagion. Skill switching from artist to different professions. For example, then the entertainment sectors could run on off-line days or, no-lock down phases.

Lack of vaccine is an impediment for contact-intensive sectors to perform suboptimally.¹¹ It has been reported that vaccination drive could revive contact-intensive

¹⁰ With quality differentiation among the artists (opera singer. Ballerina or theater personality, etc.), only the superstars with exceptional talents might survive without moving to Z-sector. In this case, the probability of price falling very low is negligible and only high end sophisticated Y-firm will survive, others will turn to casual sector. A continuum of quality differentiated creative talent with highest W_y will draw attraction. P_y might not fall.

¹¹ See Footnote 2 for a report quoted in the Economic times, India.

sectors, and that could cause reversals of fortune.¹² Digital contact tracing helps in ‘fostering participation’ so that entertainment sector or CI sectors could adopt such technology to turn the tide in their favor.

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APPENDIX FOR MATHEMATICAL PROOF

Proof for Corollary 1: Take (9) to get, $\widehat{W}_Y = -\frac{\theta_{KY}}{\theta_{SY}} \widehat{r}$ (9a).

$$\widehat{W} = \left(\frac{\widehat{P}_Z}{\theta_{LZ}} \right) - \frac{\theta_{KZ}}{\theta_{LZ}} \widehat{r} \quad (10a)$$

Using (8a) and (9b), $\widehat{Z} < 0$, and as $\widehat{r} < 0$, $\widehat{W}_X > 0$, $\widehat{W}_Y > 0$, $\widehat{W} < 0$ iff $\theta_{LZ} > \theta_{KZ}$. Thus, $\widehat{W}_X > \widehat{W}_Y$ iff

$$\frac{\theta_{KY}}{\theta_{SY}} < \frac{\theta_{KX}}{\theta_{SX}} \Rightarrow \theta_{KY} \theta_{SX} < \theta_{KX} \theta_{SY} \Rightarrow \theta_{KY} < \theta_{KX} \quad (\text{QED.})$$

Proof for Proposition 2:

Consider the following equations of change *a la* Jones (1965, 1971):

$$\theta_{SX} \widehat{W}_X + \theta_{KX} \widehat{r}_X = 0 \quad (21)$$

$$\theta_{SY} \widehat{W}_Y + \theta_{KY} \widehat{r}_Y = \widehat{P}_Y \quad (22)$$

$$\theta_{LZ} \widehat{W} + \theta_{KZ} \widehat{r}_Z = \widehat{P}_Z \quad (23)$$

Here $\widehat{W}_X, \widehat{W}_Y$ implies $\widehat{W}_X = 0 = \widehat{W}_Y$ so that from (21), $\widehat{r}_X = 0$. From (22), $\widehat{r}_Y = \widehat{P}_Y / \theta_{KY}$. When $\widehat{P}_Y \leq 0$, $\widehat{r}_Y \leq 0$, with $\theta_{KY} > 0$. From (23), $\widehat{W} < 0$, when $\widehat{P}_Z \leq 0$.

Also, $\widehat{r}_Z = \widehat{P}_Z / \theta_{KZ} - \frac{\theta_{LZ}}{\theta_{KZ}} \widehat{W} \Rightarrow \widehat{r}_Z = -\frac{\theta_{LZ}}{\theta_{KZ}} \widehat{W} > 0$ when $\widehat{P}_Z = 0$. But $\widehat{P}_Z < 0 \Rightarrow \widehat{r}_Z < 0$. (QED).

Proof for Proposition 3:

Proof: (i) Here, from (21) as before, $\widehat{P}_Y < 0$, $\widehat{r}_Y < 0$, with $\theta_{KY} > 0$. As $\widehat{P}_X = 0$, $\widehat{r}_X > \widehat{r}_Y$, higher rate of return in X induces K_Y to move to X. All K_Y moves primarily to X-sector, and unemployment of S_X will fall having more K_X at their disposal. As long as W_X and W_Y remain fixed, unemployment in S_Y will rise, all moving to Z-sector to join 'L', causing $\widehat{W} < 0$. Eventually with mobility of 'K', $r_X = r_Y = r_Z = r$ (say) will be established. Once 'r' is determined 'W' will be determined. Here fixed W_Y at high level causes unemployment in S_Y to rise, resulting in reallocation of S_Y to Z due to large shocks, and will cause transformation at the expense of Y-sector, so that all opera artist or theater personality becomes casual worker. Also, Eq. (3a) can be modified to write:

$$a_{LZ} Z + a_{SY} Y = \bar{L} + SU_Y = L' \Rightarrow \widehat{Z} > 0.$$

$$\text{From (1a)} \quad a_{SX} X = \bar{S}_X - SU_X \Rightarrow \widehat{X} = \frac{d\bar{S}_X - d(SU_X)}{\bar{S}_X - SU_X} = \frac{-d(SU_X)}{\bar{S}_X - SU_X} < 0, \text{ as } d(SU_X) < 0 \Rightarrow \widehat{X} > 0$$

$$\text{Also, from (2a), } a_{SY} Y = \bar{S}_Y - SU_Y \Rightarrow \widehat{Y} = \frac{d\bar{S}_Y - d(SU_Y)}{\bar{S}_Y - SU_Y} = \frac{-d(SU_Y)}{\bar{S}_Y - SU_Y} < 0, \text{ as } d(SU_Y) > 0$$

(ii) Suppose K_x rises causing MP of S_x to rise, and if excess demand for Online product and services pick up so that demand for S_x shoots up very high, resulting in $\widehat{W}_x > 0$, and $\widehat{W}_y < 0$. Because K_y moves out, MP of S_y falls causing W_y to decline. As, during this transitional phase, 'r' goes up, W_y might falls to a much lower level so that $W_y < \overline{W}_y, W_x > \overline{W}_x$. Then unemployment of S_y might fall, and the situation will be alike the rudimentary model in section 3.1. Y-sector will not suffer from finite change. As before, $\left(\frac{\widehat{W}_x}{\widehat{W}_y}\right) > 0, \left(\frac{\widehat{W}_x}{\widehat{W}}\right) > 0$.

$\left(\frac{\widehat{W}_y}{\widehat{W}}\right) > 0$ depending on $\theta_{KY} > \theta_{KZ}$. With $\widehat{P}_Z < 0, \widehat{W} < 0$.

Proof is similar to Proposition 2. (QED)