A Simple Dynamic Model of Big-push

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Abstract

In 1943, Paul Rosenstein-Rodan first coined the term "big-push" in his paper about growth in Eastern European economies. In 1989, Murphy et al. characterised the big-push as a static multi-equilibrium aggregate demand spillover model. Based on the model with a factory wage premium by Murphy et al. (1989), I have developed a simple multi-period dynamic model of big-push with a dynamic state variable powered by the aggregate spillover demand, where the economic growth is driven by two key parameters: wage premium and productivity. Armed with this economic growth model, I explore the dynamic behaviour and establish the economic characteristics of disequilibrium growth, which are common observable economic phenomena in the emerging economies. This model provides a simple but cogent economic structure, which may be used to explain and study economic phenomena such as the stagnation of the Japanese economy in 1990s and financial crises. In addition, this model offers plausible explanations for the empirical deviations of the Kuznets Curve and the Okun's Law as identified in the recent literature. The significant implication of this model for the Okun's Law and the Kuznets Curve in particular, and on economic theories in general, is that the economic relationships may not be static but dynamic and contingent on the state of an economy, which is determined by the ratio of wage premium on productivity and the industrialization state.

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1. Introduction

Based on the theory of big-push, Murphy et al. (1989) used the "no-industrialization trap" in a static multi-equilibrium model to explain why some countries remain unindustrialized and poor while some countries have successfully industrialized and grew rich. Nevertheless, the underdeveloped countries can break away from the "no-industrialization trap" and make a big push into industrialization by coordinating investments across industry sectors.

Have any of the underdeveloped countries which are in the "no-industrialization trap" attempted big-push? What are the economic characteristics of a big-push process? Is the "East Asian Miracle" (World Bank 1993) an outcome of a big-push process? Will big-push introduce fragility into the emerging economies which, as a result, are more susceptible to a financial crisis?

Based on the model with a factory wage premium by Murphy et al. (1989) and dismissed the myth of big-push that it is a "big-bang" or self-fulling theory, I have developed a simple dynamic model of big-push with a industrialization state variable powered by aggregate spillover demand where the economic growth is driven by two key parameters: wage premium and productivity. Using this simple economic growth model, I explore the dynamic behaviour and establish the economic characteristics of disequilibrium growth. This dynamic model also provides a simple economic structure that can be used to study economic phenomena such as the stagnation of Japanese economy in the 1990s and financial crises. In addition, this model may have significant implication for the Okun's Law and the Kuznets Curve in particular, and on the economic theories in general, that economic relationships may not be static but dynamic and contingent on the state of an economy, which is determined by the ratio of wage premium on productivity and the industrialization state.

In the remaining of this section, I briefly introduce the theory of big-push (Rosenstein-Rodan, 1943) and the static models of big-push developed by Murphy et al. (1989). In Section 2, I put forward the concept of the dynamic path of big-push and the two possible ways of initiating a big-push. Section 3 presents the construction of the simple dynamic model of big-push. The intrinsic and economic characteristics of the model, which are contingent on the ratio of wage premium on productivity and the industrialization state of an economy, are established in Section

4. Section 5 examines the implications of this model for the stagnation of Japanese economy in 1990s, the Okun's Law and the Kuznets Curve. Section 6 is the conclusion and propositions for future research.

1.1 The Theory of Big-push

Paul Rosenstein-Rodan (1943) first coined the term "big-push" in his paper about growth in Eastern European economies. The term "big-push" refers to the transitional output expansion that may occur in a less-developed economy when various manufacturing sectors expand output simultaneously, thereby increasing demand for each other's products and shifting the economy to high production equilibrium. He introduced the idea of simultaneous expansion of various sectors of the economy and coordinated investments in order for a country to get out of the trap of no-industrialization.

According to Rosenstein-Rodan, if various sectors of the economy adopt increasing returns technologies simultaneously, they can each create income that will become a source of demand for goods in other sectors, and so enlarge their markets and make industrialization profitable. With this idea that simultaneous industrialization of many sectors of the economy can be profitable even when no sector can break even industrializing alone, Murphy et al (1989) developed static models to study the conditions under which both a zero and full level of industrialization coexist. They modelled the big-push into industrialization as a move from a bad to a good equilibrium.

1.2 Static Multi-equilibrium Model

The essential feature of big-push models developed by Murphy et al (1989) is the existence of multiple equilibriums. The source of the multiplicity of equilibriums is the pecuniary externalities generated by imperfect competition with large fixed costs. An important component of industrialization for which pecuniary externalities can be crucial is investment in jointly used intermediate goods, such as infrastructure. In other words, the multiplicity of equilibriums is due to a coordination problem inherent in activities that require intermediate inputs.

For the existence of multiple Pareto-ranked equilibriums, the economy must be capable of sustaining two alternative levels of industrialization. This means that industrialization must be individually unprofitable at a low aggregate level of industrialization but individually profitable as long as a sufficient number of other sectors industrialize. In the other words, unprofitable industrialization must have spillover effects on other sectors that make industrialization in other sectors more profitable. When multiple equilibriums exist, the overall welfare will improve by moving the economy from a bad equilibrium to a good one. The government can coordinate investments across sectors and ensure that the industrial infrastructure of intermediate goods is put in place. Generally, the coordination is provided through formulation of government policy such as investment subsidies, a minimum wage policy, infrastructures construction etc.

Murphy et al. presented three mechanisms for generating a big push. In the first 2 models, industrialization of one sector raises the demand for other manufactures directly and thus makes large-scale production in other sectors more attractive. In the railroad model, industrialization in one sector increases the size of the market for railroad services used by other sectors and thus renders the provision of these services more viable.

In this paper, I develop a simple dynamic model of big-push based on the model with a factory wage premium:

> "To bring farm labourers to work in a factory, a farm has to pay them a wage premium. But unless the firm can generate enough sales to people other than its own workers, it will not be able to afford to pay higher wages. If this firm is the only one to start production, its sales might be too low for it to break even. In contrast, if firms producing different products all invest and expand production together, they can all sell their output to each other's workers and so can afford to pay a wage premium and still break even." (Murphy et al., 1989, p. 1010-1011).

Industrialization in one sector can increase spending in other sectors by altering the composition of demand. It raises the demand because workers are paid wage premiums to entice them to work in industrial plants. Hence, even a firm losing money can benefit firms in other sectors because it raises labour income and hence demand for their products.

2. The Concept

In the literature, most of the multi-equilibrium models are static models and assume the transition from low to high equilibrium to be instantaneous and self-fulfilling. The big-push models by Murphy et al. (1989) are also static and self-fulfilling models.

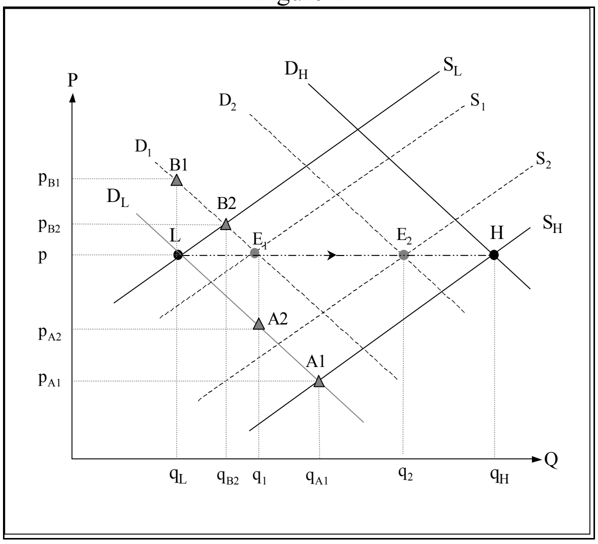
If the transition from the low to high equilibrium is not instantaneous, the economy must move along a dynamic path, which must be a series of transitional disequilibrium states, to reach the high equilibrium. In the simple dynamic model of big-push, the dynamic path is powered by the aggregate spillover demand which is driven by two key parameters: wage premium and productivity. In order to capture the essence of big-push, the dynamic path should have a trap mechanism which traps the economy at low equilibrium unless it is pushed onto the dynamic path to the high equilibrium.

If the economy is not at low or high equilibrium, it must be at a transitional state along the dynamic path of disequilibrium, where it can either move up to reach the high equilibrium or fall back to the low equilibrium, depending on the economic environment at a particular state. Before attaining the high equilibrium, there is a possibility that the economy may collapse from the present transition stage to a lower transition stage and ultimately fall back to the low equilibrium, due to a failure in the coordination of investments. Since investments are usually financed through a combination of equity and debt, the investment fails when the firm cannot meet the committed debt repayment schedule as the sales revenue and profit suffer as a result of coordination failure, which prevents the expected spillover demand from happening. The cascading financial failures may result in what is called a financial crisis, where failure in one sector of the economy can transmit to the other sectors (contagion effect) and hence the collapse of the economy. An emerging economy is apparently more susceptible to a financial crisis because big-push can leave an emerging economy in a fragile and unstable transitional disequilibrium state.

2.1 Economic Theory behind Dynamic Path

In the big-push model with a factory wage premium (Murphy al et 1989), there exist two Pareto-ranked equilibriums, as envisioned in the big-push literature. Figure 1 shows the demand and supply curves of a good produced by a firm. At the low equilibrium, the demand and supply are at equilibrium where the demand curve D_L meets the supply curve S_L, as shown as the L point in Figure 1. The high equilibrium, as shown as the H point, is also at equilibrium where the demand curve D_H meets the supply curve S_H. By moving from the low to high equilibrium, the output increases by $(q_H - q_L)$ at the price P, and hence the high equilibrium is Pareto superior to the low equilibrium.

Figure 1



In a model of a closed economy with no population growth, an increase in productivity is a necessary but not sufficient condition to lift the economy from low to high equilibrium. A firm in each sector will not invest because investment is individually unprofitable without the spillover demand from other sectors. As a result, the economy is trapped at the low equilibrium. On the other hand, an investment can be profitable if a firm from each sector invests simultaneously. By investing in new technology and paying its workers a wage premium, a firm increases its productivity and output, as shown by the shifting of supply curve from S_L to S_H. Due to an income effect which is stimulated by the extra wages earned, the demand increases, as shown by the shifting of demand curve from D_L to D_H to meet the supply curve S_H at the point H.

Apparently, the demand and supply are intertwined; one needs the other to exist first in order to move from L to H. An investment in the productivity increases the income of the workers, which in turn stimulates the demand for the extra output of other goods produced by other investments. This presents two ways for governments to stimulate the economy:

2.1.1 Stimulate supply (path L-A1-A2-E1), for example by an investment subsidy;

2.1.2 Stimulate demand (path L-B1-B2-E1), for example by a minimum wage policy.

2.1.1 Big Push by Stimulating Supply

Taking advantage of a government investment subsidy, an entrepreneur Firm-M decides to industrialize and invest in new production technology. Due to the increase in productivity and the fact that investment is lumpy, the Firm-M's supply curve shifts from S_L to S_H as shown in Figure 1. At the point A_1 where D_L meets S_H, the Firm-M is not able to make a profit without the government subsidy.

Investment is a venture with a time frame (eg. short-term or long-term investment) and the common investment plan has low sales forecasts for the initial periods and increased the sales forecasts at later periods. With the conventional wisdom that time is essential for sales and marketing campaigns to create product awareness and stimulate demand, the Firm-M forecasts and produces q_1 which is lower than q_H at full production capacity. This is represented by the shifting of supply curve S_L to a transitory supply curve S_1.

Without a spillover demand, the Firm-M has to clear its output at the price P_{A2} where D_L intersects with q1 at point A2. As the Firm-M pays its workers a wage premium for higher skill, this creates spillover demands for the complementary goods and hence shifts the demand curves of firms in other sectors from D_L to D_1. Faced with the spillover demand, a proportion of firms in other sectors may decide to invest in the new technology and shift their supply curves from S_L to S_1.

As more firms industrialize, this shifts the demand curve of Firm-M from D_L to D_1 or most probably even higher demand at D_2 where the Firm-M further shifts its transitory supply curve to S_2. Following the same principle, the demand curve moves from D_1 to D_2 and eventually arrives at D_H as more and more firms industrialize. The transitory supply curve shifts from S_1 to S_2 and eventually arrives at the supply curve S_H. In summary, the economy moves from the low equilibrium point L to E1 and then to E2, and eventually reaches the high equilibrium at point H where the demand curve D_H meets the supply curve S_H.

2.1.2 Big-push by Stimulating Demand

With a minimum wage policy in one sector of the economy, the government indirectly raises the disposable income of the workers of that sector. Through the income effect, there is now a higher demand for the complementary goods in other sectors, as shown by the shifting of demand curve in a northeast direction, from D_L to D_1. As the demand is now greater than the supply, the prices of goods may temporarily increase to P_{B1}, at the point B1 where D_1 intersects with q_L.

Responding to the spillover demand, an entrepreneur Firm-M may drop the price from P_{B1} to P_{B2} while it increases its output form q_L to $q_{B2,}$ where the D_1 meets with S_L at point B2. Due to competitive market in each sector, the price is arbitrated to remain at p, as the Firm-M does not want to lose sales to the competitive fringes. This drives the Firm-M to industrialize and invest in new technology, as shown by shifting the supply curve from S_L to S_H. At the price p, the Firm-M can now produce q_1 at the point E_1 where the demand curve D_1 intersects with the transitory supply curve S_1.

Since the Firm-M pays its workers a wage premium to work in a new technological environment, this in turn raises the demand for the complementary goods of other sectors, by shifting their demand curves from D_1 to D_2. Following the same principle, as more and more firms industrialize, the economy moves from the low equilibrium at point L to high equilibrium at point H, where the demand curve D_H meets the supply curve S_H.

2.2 Conclusion

From the above two scenarios, the dynamic path is the zigzag path around the horizontal line at the price P from the low equilibrium at point to the high equilibrium at point H.

3. The Model

Based on the aggregate demand spillover model with a factory wage premium as discussed in Section IV of Murphy et al. (1989), I construct a simple multi-period dynamic model of big-push. This model assumes that there are N complementary sectors in the economy.[1] Each complementary sector produces a unique good and hence there are N types of goods which are complementary. This model assumes that all goods have the same price of unity.[2] In addition, all goods are assumed to be perishable and ruined at the next period.[3]

[1] N is the number of firms that produce complementary goods in an economy. Therefore N remains constant assuming there is no introduction of new or obsolete goods which can affect the complementarity. "Economic growth through introduction of new goods" can be developed as an extension to this model.

[2] For perfect coordination, the assumption that the prices of all goods are the same is necessary to ensure the consistency with the assumption that each sector has only one monopolist firm. For simplicity, the price is set to

In the economy, there are two types of firms in each sector. First, there is a competitive fringe of firms that converts one unit of labour input into one unit of output with constant return to scale (cottage) production. Second, there is a unique firm, referred to as a "monopolist" firm in Murphy et al. (1989), which alone has access to an increasing return to scale (IRS) technology. The monopolist firm can invest F units of labour in the new technology which allows each unit of labour to produce $\alpha > 1$ units of output. Since there is only one monopolist firm in each sector, hence there are N monopolist firms in the economy.[4]

This model assumes that each firm is endowed with L units of labour, which is also the numeraire. Then the output of each firm is $Y = L$. At time t, where $t \geq 0$, there are $N_{C,t}$ cottage-firms, where a cottage-firm is a monopolist firm which uses cottage production. Likewise, there are $N_{T,t}$ technology-firms, where a technology-firm is a monopolist firm which industrializes and invests in new technology. This model assumes homogeneity for all cottage-firms and technology-firms. In the economy, the aggregate number of monopolist firms is $N = N_{C,t} + N_{T,t}$. For convenience, this group of N monopolist firms is known as a 'complementary-group-economy' or simply a 'group-economy'. Therefore, the fraction of industrialized monopolist firms at time t is:

$$n_t = \frac{N_{T,t}}{N} \qquad \text{where } 0 \leq n_t \leq 1,$$

and hence, $N_{C,t} = (1 - n_t)N$ and $N_{T,i} = n_t N$.

In this model, n_t characterises the level of industrialization at which economy has arrived at or simply the industrialization state of the economy. At time $t = 0$, there is no firm industrialized and hence $n_0 = 0$. As the big-push process starts at $t = 1$, the kick-start fraction of industrialized firms needs to be greater than zero, $n_1 > 0$, in order to launch the big-push process. As shown

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unity. A different price for different type of goods implies that each sector may have different number of monopolistic firms for perfect coordination.

[3] This assumption avoids the complication of inventory holding and output adjustment, which will not affect the general characteristics of big-push except the cost of inventory holding. This is a reasonable assumption for a long timeframe industrialization model where the focus is on the economic characteristics at the aggregate level.

[4] This assumption is to ensure that there is only one firm industrialize in each sector for perfect coordination. In fact, perfect coordination can also be achieved with equal number of firms industrialized in each sector. For consistency, we also use the same assumption and terminology.

later in Section 3.12, n_t is a state variable which depends on the ratio of wage premium to productivity and the kick-start fraction of industrialized firms.

A cottage-firm pays its workers a wage of unity, $w_C = 1$. On the other hand, a technology-firm has to pay a wage premium $v > 0$, in order to entice skilled workers to work in a factory which uses a new technology. Since prices of all goods are always kept at unity by assumption, therefore the wage rate of technology-firm is $w_T = 1 + v$.

This model assumes homothetic[5] preferences and that each worker buys an equal quantity of goods produced by each firm or spends his entire income equally on the goods produced by each firm. When a particular goods produced by a firm is in short supply, the workers will save their incomes rather than buy goods produced by the other firms.

Assuming that the monopolist firm maximizes its price-taking demand curve as given, it industrializes only if there is a profit at the price it charges. Since it loses all its sales to the fringe if it charges more, it only sells at the same price charged by the fringe, which is unity. In addition, this model assumes that the monopolist firm faces a unitary elastic demand curve and hence it would not want the price to be lower than unity.[6]

At time $t1$, where $t1 \geq 0$, a technology-firm borrows a loan, B (units of labour), which is also the cost of the new technology, to finance its investment. With an increase in productivity, the technology-firm starts producing α units of output at the next period. Using the profit of each period, the technology-firm will make a periodic repayment of F_t until the loan is fully settled at time $t2$, where $t2 \geq t1$. Indirectly, all the equations derived for a technology-firm must have time subscript of $t \geq t1$. Hence, the loan equals the present value of its repayments or profits from $t1$ to $t2$:

$$B = \sum_{j=t1+1}^{t2} \frac{F_j}{(1+r)^{j-t1}}$$ where r is the applicable interest rate.

[5] In order to achieve perfect coordination, this assumption of homothetic preference ensures the consistency with the assumption of homogeneity of technology-firm and the assumption of only one monopolist firm in each sector.

[6] This assumption is to ensure that the dynamic path is a straight horizontal line at unit price without the transitory price adjustment.

3.1 Output and Labour Cost

Until it invests in the new technology, a cottage-firm Ci, where $1 \le i \le N_{C,t}$, has a constant output for every period:

$$Y_{Ci,t} = Y_{Ci} = L \qquad (1)$$

Since a cottage-firm pays a constant wage, $w_{Ci} = w_C = 1$ to its workers, the labour cost of a cottage-firm for each period, which is constant over time, is:

$$W_{Ci,t} = W_{Ci} = w_{Ci} L = L \qquad (2)$$

A technology-firm Ti, where $1 \le i \le N_{T,t}$, employs an IRS technology which has a productivity gain of $(\alpha - 1)$. Because it pays its workers a wage premium of v, a technology-firm can only afford to employ $\varepsilon_t L$ of workers, where ε_t depends on its sales forecast,[7] in order to maintain its profitability. Thus, ε_t, which is also known as the 'employment rate' of technology-firm, is the ratio of number of employed workers on labour endowment (*L*). The jobless workers are not restricted to a particular firm and are free to seek employment in other firms. Therefore the output of a technology-firm at time t is:

$$Y_{Ti,t} = \alpha \varepsilon_t L \qquad (3)$$

As a monopolist firm is only willing to industrialize if its output increases, the employment rate of technology-firm must be greater than the inverse of productivity as shown below:

$$Y_{Ti,t} = \alpha \varepsilon_t L > L$$

$$\therefore \quad 1/\alpha < \varepsilon_t \le 1$$

As the wage rate of technology-firm is $w_{Ti} = w_T = 1 + v$, the labour cost of a technology firm is:

$$W_{Ti,t} = w_{Ti} \varepsilon_t L = (1 + v) \varepsilon_t L\,. \qquad (4)$$

[7] The incorporation of a sales-forecasting model, such as the adaptive expectation model, will not affect the general characteristics of this model except the inaccuracy will slightly dampened the dynamic path of big-push, in comparison with the dynamic path at the optimal employment rate (prefect forecasting).

3.2 Unemployment

In the group-economy, there are $Nn_t(1-\varepsilon_t)L$ unemployed workers and each of them collects an unemployment benefit of w_U from the government.[8] Therefore, the unemployment rate of the group-economy is:

$$U_t = \frac{Nn_t(1-\varepsilon_t)L}{NL} = n_t(1-\varepsilon_t) \tag{5}$$

For simplicity, the unemployment benefit is assumed to be the same as the wage rate of cottage-firm, i.e. $w_U = w_{Ci} = 1$.[9] At time *t*, the cost to the government in maintaining the unemployment benefits is:

$$W_{U,t} = Nn_t(1-\varepsilon_t)Lw_U = Nn_t(1-\varepsilon_t)L \tag{6}$$

3.3 Demand

As all workers attempt to spend their entire incomes, the aggregate demand for goods of the group-economy at time t is equal to the sum of the workers' income of cottage-firms, i.e. Equation (2) multiplied by $N(1-n_t)$, and that of technology-firms, i.e. Equation (4) multiplied by Nn_t, and the unemployment benefits of unemployed workers, i.e. Equation (6):

$$\begin{aligned} Q_t \quad &= N(1-n_t)Lw_{Ci} + Nn_tL\varepsilon_t w_{Ti} + Nn_t(1-\varepsilon_t)Lw_U \\ &= N(1-n_t)L + Nn_tL\varepsilon_t(1+v) + Nn_t(1-\varepsilon_t)L \\ &= N(1+n_t\varepsilon_t v)L \end{aligned} \tag{7}$$

Based on the assumption that each worker buys equal quantity of goods produced by each firm, both cottage-firm and technology-firm face a similar demand:

$$Q_{Ci,t} = Q_{Ti,t} = \frac{Q_t}{N} = (1+n_t\varepsilon_t v)L \tag{8}$$

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[8] Without an unemployment benefit system, the unemployed workers may continue to consume the goods produced by both the cottage-firms and the technology-firms using their savings. When their savings are used up, instead of growing towards the high equilibrium, the economy may fall back to the low equilibrium or even into depression.

[9] If $w_U = w_C$, the workers may not have the incentive to work. In order to minimize the work disincentive effect, the government can set the dole w_U to be much lower than w_C. As long as the dole is greater than the critical value, w_{UC}, as shown in Equation (9), the spillover demand remains positive and the dynamic path continues to move towards high equilibrium. A lower w_U does not affect the characteristics of the model except it dampens or slows down the big-push process.

3.4 Critical Value of Unemployment Benefit

The critical value of unemployment benefit is the minimum unemployment benefit in order to generate a positive aggregate spillover demand to power the big-push process as discussed in Section 3.12. Subtracting the initial demand (NL) from the aggregate demand (Q_t), the aggregate spillover demand of the economy is $D_t = Q_t - NL$. By equating the aggregate spillover demand to zero, the critical value of the unemployment benefit can be derived as shown below:

$$D_t = Q_t - NL = 0$$

Substituting Equation (7) into the above equation:

$$\therefore \quad NL(1-n_t) + NLn_t\varepsilon_t(1+v) + NLn_t(1-\varepsilon_t)w_{UC} - NL = 0$$

$$\therefore \quad w_{UC} = \frac{1-\varepsilon_t(1+v)}{1-\varepsilon_t} \tag{9}$$

When the unemployment benefit is lower than the critical value w_{UC} as shown in Equation (9), the aggregate spillover demand is negative and subsequently the economy will fall into depression, similar to the aggregate demand argument by Keynes (1936).

3.5 Surplus Inventory / Under-employment

By subtracting its output from the demand for its goods at time *t*, the period inventory of a technology firm is:

$$G_{Ti,t} = Y_{Ti,t} - Q_{Ti,t} = \alpha\varepsilon_t L - (1+n_t\varepsilon_t v)L = ((\alpha - n_t v)\varepsilon_t - 1)L \tag{10}$$

With imperfect knowledge of demand, the technology-firm may face one of the following situations depending on its sales forecast and hence its output:

i. *Surplus Inventory* ($G_{Ti,t} > 0$)

   When the technology-firm is too aggressive in its sales forecast, it will have surplus inventory if it produces more goods than the demand, i.e. $Y_{Ti,t} > Q_{Ti,t}$ or $\varepsilon_t > 1/(\alpha - n_t v)$.

ii. *Under-employment* ($G_{Ti,t} < 0$)

   When the technology is too conservative in its sales forecast, it will face excess demand for its goods if its output is less than the demand, $Y_{Ti,t} < Q_{Ti,t}$ or $\varepsilon_t < 1/(\alpha - n_t v)$. Since the technology-firm has industrialized, this excess demand faced by the technology-firm does not constitute as a spillover demand but a loss of sales revenue due to shortage of stock.

iii. *Zero inventory* ($G_{Ti,t} = 0$)

When the technology-firm makes accurate sales forecast for all periods, it will not hold inventory if its output exactly equals the demand, i.e. $Y_{Ti,t} = Q_{Ti,t}$ or $\varepsilon_t = 1/(\alpha - n_t v)$.

3.6 The Optimal Employment Rate

Assuming that a technology-firm has the perfect knowledge of future demand for its goods, by equating the output to meet the future demand, the optimal employment rate of a technology-firm is: [10]

$$Y_{Ti,t} = Q_{Ti,t}$$

$$\therefore \quad \alpha\varepsilon_t L = (1 + n_t \varepsilon_t v)L$$

$$\therefore \quad \varepsilon_t = \frac{1}{\alpha - n_t v} \qquad \text{where } 1/\alpha \le \varepsilon_t \le 1. \tag{11}$$

The employment rate will recover to 100% ($\varepsilon_t = 1$) at the *high full-employment equilibrium* when the economy attains full industrialization ($n_\tau = 1$) and all technology-firms pay their workers a wage premium equals the productivity gain ($v = \alpha - 1$), as discussed in Section 4.5.4.

Substituting the optimal employment rate, Equation (11) into Equation (3), the output of a technology-firm is:

$$Y_{Ti,t} = \alpha\varepsilon_t L = \frac{\alpha}{\alpha - n_t v} L = \frac{L}{1 - n_t \theta} \tag{3a}$$

where θ is the ratio of wage premium on productivity ($\theta = v/\alpha$) where $0 \le \theta < \gamma$, as $v < \alpha - 1$, and $\gamma = (\alpha - 1)/\alpha$, which is the proportionate productivity gain.

At the optimal employment rate, a technology-firm has no excess inventory. Compared to its output before industrialization (or that of a cottage-firm), the extra output of a technology-firm is:

$$\nabla Y_{Ti,t} \equiv Y_{Ti,t} - Y_{Ci} = n_t \varepsilon_t v L = \frac{n_t v}{\alpha - n_t v} L = \frac{n_t \theta}{1 - n_t \theta} L \tag{12}$$

[10] At the optimal employment rate, a technology-firm maximizes its profit by maximizing its sales while minimizing the holding cost of inventory.

3.7 Spillover Demand

The spillover demand of a cottage-firm equals its demand minus its output, i.e. Equation (8) minus Equation (1):

$$D_{Ci,t} = Q_{Ci,t} - Y_{Ci} = n_t \varepsilon_t v L = \nabla Y_{Ti,t} \tag{13}$$

Since the demand for the good produced by a cottage-firm is the same as that of a technology-firm, the spillover demand of a cottage-firm is the same as the extra output of a technology-firm. A cottage-firm cannot fulfil its spillover demand unless it industrializes and increases its output by investing in the new technology. Therefore the spillover demand has an incentive effect of enticing the cottage-firm to industrialize. In reality, the spillover demand may persist or diminish in the future. This model, however, assumes that the spillover demand vanishes at the next period.

At the optimal employment rate, the spillover demand of a cottage-firm is:

$$D_{Ci,t} = \frac{n_t v}{\alpha - n_t v} L = \frac{n_t \theta}{1 - n_t \theta} L \tag{13a}$$

Hence, the aggregate spillover demand of the economy equals the spillover demand of a cottage-firm multiplied by the number of cottage-firm, i.e. Equation (13) multiplied by $N(1-n_t)$:

$$D_{C,t} = N(1-n_t) D_{Ci,t} = N(1-n_t) n_t \varepsilon_t v L \tag{14}$$

3.8 Operating Profit

Without investing in the new technology, a cottage-firm is just breaking even and hence has zero operating profit, i.e. Equation (1) minus Equation (2):

$$\Pi_{Ci,t} = \Pi_{Ci} = Y_{Ci} - W_{Ci} = 0$$

If its output is greater than or equal to the demand, then the operating profit before loan repayment of a technology-firm equals its output minus its labour cost, i.e. Equation (3) minus Equation (4); otherwise, the operating profit of a technology-firm equals the demand minus its labour cost, i.e. Equation (8) minus Equation (4):

$$\begin{aligned}\Pi_{Ti,t} &= Y_{Ti,t} - W_{Ti,t} \\ &= \alpha\varepsilon_t L - (1+v)\varepsilon_t L && \text{for } \varepsilon \le \frac{1}{\alpha - n_t v} \\ &= \varepsilon_t(\alpha - 1 - v)L\end{aligned}$$

$$(15)$$

$$\begin{aligned}\Pi_{Ti,t} &= Q_{Ti,t} - W_{Ti,t} \\ &= (1 + n_t\varepsilon_t v)L - (1+v)\varepsilon_t L && \text{for } \varepsilon \ge \frac{1}{\alpha - n_t v} \\ &= [1 + \varepsilon_t(v(n_t - 1) - 1)]L\end{aligned}$$

A monopolist firm is only willing to industrial if it can make a profit after it industrializes. Therefore, a necessary condition for a monopolist firm to consider industrialization is:

$$\begin{aligned}&\Pi_{Ti,t} > 0 && && \Pi_{Ti,t} > 0 \\ \therefore\quad &\varepsilon_t(\alpha - 1 - v)L > 0 && \text{or} \quad \therefore && [(1-\varepsilon_t) - \varepsilon_t v(1-n_t)]L > 0 \\ \therefore\quad &\alpha > 1 + v && \quad\;\; \therefore && \varepsilon < \frac{1}{1 + v(1-n_t)}\end{aligned}$$

At the optimal employment rate, the operating profit of a technology-firm is:

$$\Pi_{Ti,t} = \frac{\alpha - 1 - v}{\alpha - n_t v}L = \frac{\gamma - \theta}{1 - n_t\theta} \qquad (15a)$$

3.9 Savings

The workers of technology-firms have "forced savings" because their extra demands (due to the income effect) for the goods produced by the cottage-firms cannot be fulfilled. For $\varepsilon \le 1/(\alpha - n_t v)$, the total demand is greater than or equal to the total supply of the group-economy and hence there is no surplus inventory. Then the period savings of a technology-firm equals the total demand (Equation (7) minus the total supply of the group-economy (Equation (1 multiplied by $N(1-n_t)$ plus Equation (3 multiplied by Nn_t) divided by the number of technology-firms (Nn_t). For $\varepsilon \ge 1/(\alpha - n_t v)$, the period savings of a technology-firm at time *t* is simply the aggregate spillover demand of cottage-firms divided by the number of technology-firms, i.e. Equation (14) divided by Nn_t:

$$
\begin{aligned}
S_{Ti,t} &= \frac{Q_t - (Nn_t\alpha\varepsilon_t L + (1-n_t)L)}{Nn_t} = \\
&= \frac{(1+n_t\varepsilon_t v)NL - (n_t\alpha\varepsilon_t + (1-n_t))NL}{Nn_t} \qquad \text{for} \quad \varepsilon \le \frac{1}{\alpha - n_t v} \\
&= (1+\varepsilon_t(v-\alpha))L
\end{aligned}
\tag{16}
$$

$$
S_{Ti,t} = \frac{D_{C,t}}{Nn_t} = \frac{N(1-n_t)n_t\varepsilon_t vL}{Nn_t} = (1-n_t)\varepsilon_t vL \qquad \text{for} \quad \varepsilon \ge \frac{1}{\alpha - n_t v}
$$

At optimal employment rate, the period saving of a technology-firm is:

$$
S_{Ti,t} = \frac{(1-n_t)v}{\alpha - n_t v} L = \frac{(1-n_t)\theta L}{1-n_t\theta} \tag{16a}
$$

In summary, compared to the workers of cottage-firm, each of $\varepsilon_t L$ workers of a technology-firm has a higher income of v, of which he spends $n_t v$ on the goods produced by the technology-firms. Hence, compared to a worker of cottage-firm, each worker of technology-firm has an extra consumption of $n_t v$. In addition, he has a saving of $(1-n_t)v$ because his extra demand for the goods produced by the cottage-firm cannot be fulfilled.

3.10 Consumption

For a cottage-firm, the total consumption of workers equals the labour cost, i.e. Equation(2):

$$
C_{Ci,t} = C_{Ci} = W_{Ci} = L \tag{17}
$$

Similarly, the total consumption of unemployed workers equals the total unemployment benefits, i.e. Equation (6):

$$
C_{U,t} = W_{U,t} = Nn_t(1-\varepsilon_t)L \tag{18}
$$

On the other hand, the total consumption of workers of a technology-firm equals the labour cost minus the period savings of a technology-firm, i.e. Equation (4) minus Equation (16):

$$
\begin{aligned}
C_{Ti,t} &= W_{ti,t} - S_{Ti,t} \\
&= (1+v)\varepsilon_t L - (1+\varepsilon_t(v-\alpha))L \qquad \text{for} \quad \varepsilon \le \frac{1}{\alpha - n_t v} \\
&= (\varepsilon_t(1+\alpha)-1)L
\end{aligned}
$$

$$
\begin{aligned}
C_{Ti,t} &= W_{ti,t} - S_{Ti,t} \\
&= (1+v)\varepsilon_t L - (1-n_t)v\varepsilon_t L \qquad \text{for} \quad \varepsilon \ge \frac{1}{\alpha - n_t v} \\
&= (1+n_t v)\varepsilon_t L
\end{aligned}
\tag{19}
$$

The total extra consumption of workers of a technology-firm equals the total consumption of a technology-firm minus the original consumption (i.e. the wage rate of cottage-firm multiplied by the number of workers of a technology-firm $\varepsilon_t L$), i.e. Equation (19) minus $w_{Ci}\varepsilon_t L$:

$$
\begin{aligned}
\nabla C_{Ti,t} &= C_{Ti,t} - w_{Ci}\varepsilon_t L \\
&= (\varepsilon_t(1+\alpha)-1)L - \varepsilon_t L \qquad \text{for} \quad \varepsilon \le \frac{1}{\alpha - n_t v} \\
&= (\alpha\varepsilon_t - 1)L
\end{aligned}
$$

$$
\begin{aligned}
\nabla C_{Ti,t} &= C_{Ti,t} - w_{Ci}\varepsilon_t L \\
&= (1+n_t v)\varepsilon_t L - \varepsilon_t L \qquad \text{for} \quad \varepsilon \ge \frac{1}{\alpha - n_t v} \\
&= n_t \varepsilon_t v L
\end{aligned}
\tag{20}
$$

At the optimal employment rate, the total extra consumption of workers of a technology-firm is:

$$
\nabla C_{Ti,t} = n_t \varepsilon_t v L = \frac{n_t v}{\alpha - n_t v} L = \frac{n_t \theta}{1 - n_t \theta} L \tag{20a}
$$

3.11 Finance the Investment

Using its operating profit to finance its investment in the new technology, the available fund of a technology firm for investment at each period is $\Pi_{Ti,t}$, i.e. Equation (15). To finance the new technology, the technology-firm takes a loan B at time $t1$ and pays off the loan at time $t2$. Since the firm takes a total of $(t2 - t1)$ periods to repay the loan, the capability of a technology-firm to finance the investment at time $t1$ is the present values of its operating profits:

$$\Im(L) = \sum_{j=t1+1}^{t2} \frac{\Pi_{Ti,j}}{(1+r)^{j-t1}} = \sum_{j=t1+1}^{t2} \frac{\varepsilon_t(\alpha - 1 - v)}{(1+r)^{j-t1}} L \qquad \text{for} \qquad \varepsilon \leq \frac{1}{\alpha - n_t v}$$

$$\Im(L) = \sum_{j=t1+1}^{t2} \frac{\Pi_{Ti,j}}{(1+r)^{j-t1}} = \sum_{j=t1+1}^{t2} \frac{1 + \varepsilon_t(v(n_t - 1) - 1)}{(1+r)^{j-t1}} L \qquad \text{for} \qquad \varepsilon \geq \frac{1}{\alpha - n_t v} \tag{21}$$

where r is the applicable period interest rate.

At the optimal employment rate, the available fund for investment is:

$$\Im(L) = \sum_{j=t1+1}^{t2} \frac{\alpha - 1 - v}{(\alpha - n_t v)} \frac{L}{(1+r)^{j-t1}} = \sum_{j=t1+1}^{t2} \frac{\gamma - \theta}{(1 - n_t \theta)} \frac{L}{(1+r)^{j-t1}} \tag{21a}$$

The monopolist firm will industrialize if the following three necessary and sufficient conditions are satisfied:

i. $\alpha > 0$, $v > 0$ and $\alpha > 1 + v$. The productivity gain from using the new technology must be greater than the wage premium paid to the workers.

ii. $\Pi_{Ti,t} \geq F_t L$ and $\Im \geq B$. The investment fund available is equal to or greater than the cost of the new IRS technology; and the profit at each period is equal to or greater than the period repayment.

iii. There is an efficient capital market where there are willing financiers for the investments.

However, the above three conditions are necessary but not sufficient to ensure that the economy attains the high-equilibrium. For a successful big-push, the following conditions must prevail as well:

i. All monopolist firms industrialize and are successful in their investments;
ii. The goods produced by the industrialized firms are complementary;
iii. All workers spend their incomes on domestic complementary good;
iv. The government is capable of sustaining the unemployment benefits.

3.12 Dynamic Path

Predicting that the spillover demand will persist in the future, the cottage-firms may decide to industrialize so that they can increase their outputs and incomes. Indirectly, the excess spillover demand entices the cottage-firms to industrialize because they can produce higher output, while the workers can earn higher wages and hence can afford higher consumption. Facing spillover demand, the cottage-firms have the follow two options:

i. If the profit generated by the spillover demand is not sufficient to cover the investment cost, the cottage-firm waits for the spillover demand to increase, as Equation (13) shows that the spillover demand increases with the industrialization state.
ii. If the spillover demand is sufficient to cover the investment cost, the cottage-firm industrializes and invests in new technology so that it can increase its output to fulfil the spillover demand.

In fact, the spillover demand can be treated as a signal for investment. Increasing spillover demand for some given number of consecutive periods may be a good signal for investment to some entrepreneurs. There are many possible ways an entrepreneur can react to spillover demands. This model employs a very simple method by assuming that the number of cottage-firm enticed to industrialize equals the aggregate spillover demand divided by the output of a cottage-firm. In short, this model assumes that the probability of industrialization of a monopolist firm depends on the level of aggregate spillover demand.

Knowing the aggregate spillover demand of the economy, the proportion of cottage-firm enticed to industrialize equals the aggregate spillover demand divided by the output of a cottage-firm and the number of monopolist firms, i.e. Equation (14) divided by NL:

$$\frac{D_{C,t}}{NY_{Ci}} = \frac{D_{C,t}}{NL} = (1 - n_t) n_t \varepsilon_t v$$

Then the industrialization state, n_t at time t, equals to the previous industrialization state, n_{t-1}, plus the proportion of the newly industrialized firms[11]:

$$n_t = n_{t-1} + \frac{D_{C,t-1}}{NL}$$

$$\therefore \qquad n_t = n_{t-1} + (1 - n_{t-1}) n_{t-1} \varepsilon_{t-1} v \qquad \text{where } t \geq 1,\ n_0 = 0 \text{ and } n_\tau = 1. \qquad (22)$$

[11] Leow (2004) extends this equation to allow fluctuation of industrialization state due to investment failure and hence deindustrialization of firms. Depending on the cascading effect, a big cascading collapse of firms will create a financial crisis.

At the optimal employment rate, the industrialization state variable is:

$$n_t = n_{t-1} + (1 - n_{t-1})\frac{n_{t-1}v}{\alpha - n_{t-1}v} = n_{t-1} + (1 - n_{t-1})\frac{n_{t-1}\theta}{1 - n_{t-1}\theta} \tag{22a}$$

Mathematically, Equation (22a) can also be expressed as a function of three parameters: $n_t\{t, n_1, \theta\}$. Thus the industrialization state variable is determined by the following three parameters:

i. n_t increases with t, time;
ii. n_t increases with n_1, the kick-start fraction of industrialized firms;
iii. n_t increases faster with θ. If θ is zero, industrialization will not progress. The higher is the ratio of wage premium on productivity, the higher is the spillover demand which will entice more cottage-firms to industrialize.

Equation (22) characterises the dynamic path of big-push, as it determines the industrialization state n_t at time t. Equations, which contain the industrialization state variable, also depend on these three parameters: time, kick-start fraction and ratio of wage premium to productivity.

We can find the steady states of the dynamic path by substituting $\bar{n} = n_t = n_{t-1}$ into Equation (22) and solving for $\bar{n}$. The steady states of the dynamic path are $\bar{n} = 0$ and $\bar{n} = 1$, which are the low and high equilibrium of big-push.

4. The Characteristics

Armed with the model constructed in Section 3, I explore and establish the intrinsic and economic characteristics of big-push, and analyse their dynamic behaviours. As discussed in Section 4.1 to 4.4, this model has four intrinsic characteristics:

i. This model is a *multi-equilibrium* model;
ii. It has the low and high steady states, which are the *low and high equilibrium*, corresponding to no-industrialization and full-industrialization state;
iii. It needs a "*kick-start*" (a big-push) to initiate a big-push process;

iv. It exhibits a typical *S-shaped dynamic path*. However, it can exhibit chaotic behaviour when the ratio of wage premium on productivity is larger than a certain value.

In addition, within its simple economic structure, this model exhibits six economic characteristics of big-push: (1) high growth, (2) spillover demand, (3) excess supply, (4) unemployment, (5) income inequality, and (6) debt and capital inflow, which are discussed in Section 4.5 to 4.10 respectively.

4.1 Multiple Equilibrium

This simple dynamic model is able to demonstrate similar multiple-equilibrium characteristic as depicted in the Murphy et al. (1989). The firm will industrialise if its profit at each period, as shown in Equation (15a), is equal to or greater than the period repayment (for the loan to purchase new technology) of the same period, F_t:

$$\Pi_{Ti,t} = \frac{\alpha - 1 - v}{\alpha - n_t v} L \geq F_t L$$

The above condition shows that this simple dynamic model of big-push can have two equilibriums, one with and one without industrialisation. In the low equilibrium, no firm incurs the fixed cost for fear of not being able to break even, and the population stays in cottage production. For no industrialization to take place, where $n_t = 0$, the following condition must prevail:

$$\Pi_{Ti,t} \leq F_t L$$

$$\therefore \quad \alpha(1 - F_t) - (1 + v) \leq 0 \tag{23}$$

In the high equilibrium, all sectors industrialize. All firms expect a high level of sales resulting from simultaneous labour-saving industrialisation (where $n_t = 1$) and are consequently happy to incur the fixed cost B to invest in new technology, only if their profits are positive:

$$\Pi_{Ti,t} \geq F_t L$$

$$\therefore \quad (\alpha - v)(1 - F_t) - 1 \geq 0 \tag{24}$$

The two conditions, as shown in Equation (23) and (24), suggest that there always exist some values of *F* for which both equilibriums coexist. For these values of *F*, the economy is capable of a big-push, whereby it can move from low to high equilibrium. This illustrates that the economy is capable of sustaining two alternative levels of industrialization, which are the low and high equilibrium. At low equilibrium, it is unprofitable for each firm to industrialize individually. However, it becomes profitable to industrialize as long as there is a sufficient number of firms from other sectors industrialize simultaneously.

Plotting the two conditions as shown in Equation (23) and (24) in a graph of productivity versus wage premium with $F = 0.5$, Figure 2 shows that there exist three possible regions: (1) region of high equilibrium, (2) region of low equilibrium and (3) region of multi-equilibrium. The static model by Murphy et al. (1989) assumes that the economy is either at low or high equilibrium, and makes the expectation of industrialization self-fulfilling. Their big-push takes the form of simultaneous industrialization of many sectors, each generating future income that helps the profitability of other sectors.

Figure 2 – Equation (23) and (24)

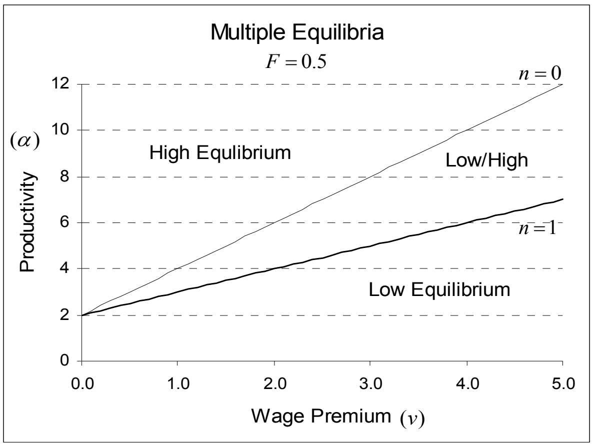
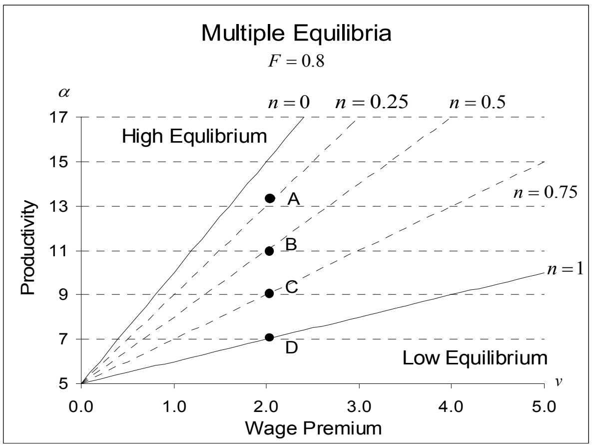


Figure 3– Equation (23) and (24)



On the contrary, this model is not a self-fulfilling but a progressive growth model where a big-push could be as simple as a government building an infrastructure project. Figure 3 show an hypothetical example where there is an economy consists of only four monopolist firms, Firm-A to Firm-D. Each firm requires a different technology which offers different productivity at the same cost of $F = 0.8$. If the government is able to encourage the Firm-D to industrialize first, then the Firm-A becomes profitable to industrialize since $n = 0.25$ after the Firm-D industrializes. Similarly, the Firm-B becomes profitable to industrialize at $n = 0.5$ after the Firm-A and Firm-D industrialize. Subsequently the Firm-C industrializes and the economy attains full industrialization. As long as the government is able to encourage or 'push' the firm with highest 'industrialization barrier' to industrialize first (Firm-D in this example), the economy may just roll itself progressively to full industrialization. Large infrastructure project is possibly the investment with the highest 'industrialization barrier' which the government of emerging economy needs to establish in order to facilitate a big-push process. Infrastructure in general and railroads in particular, has been commonly credited with being the important component of the big push (Rostow 1960, Rosenstein-Rodan 1961).

Dismissing the static and self-fulfilling models by Murphy et al (1989), this model introduces the transitional disequilibrium states and captures the significance of big-push to steer the economy from low to high equilibrium by introducing a big-push as a 'kick-start' to a industrialization process as described in Section 4.3.

4.2 Low and High Equilibrium (n_0, n_τ)

The workers of a technology-firm have aggregate extra consumption by the amount as show in Equation (20). This extra consumption increases with the industrialization state, and it increases faster with a higher wage premium. Since there is no extra consumption for the workers of cottage-firm, the extra consumption of the economy equals the extra consumption of a technology-firm multiplied by the number of technology-firm, i.e. Equation (20) multiplied by Nn_t:

$$\nabla C_t = Nn_t \nabla C_{Ti,t} = \frac{n_t^2 v}{\alpha - n_t v} NL = \frac{n_t^2 \theta}{1 - n_t \theta} NL \qquad (25)$$

Figure 4 – Equation (25)

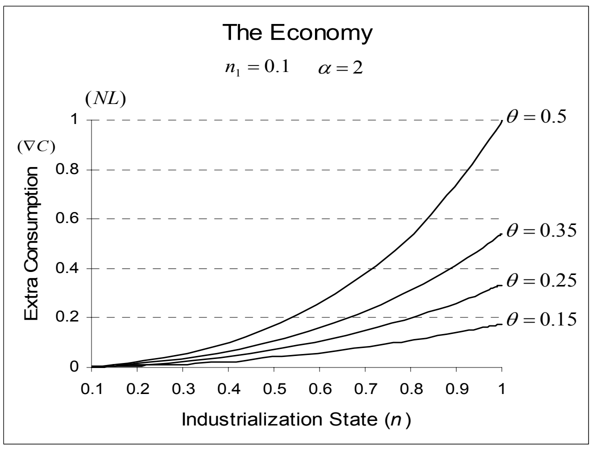
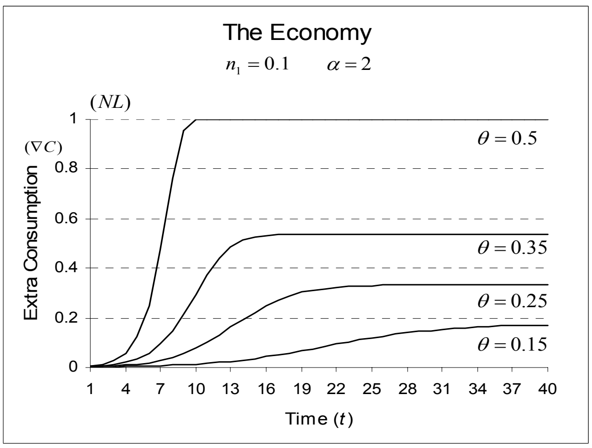


Figure 5 – Equation (25)



Equation (25) shows that the extra consumption of the economy increases exponentially with the industrialization state as shown in Figure 4. Figure 5 shows the plot of the extra consumption of the group-economy against time is an S-shaped curve.

When there is no firm industrialized ($n_0 = 0$), there is no extra consumption, i.e. $\nabla C_0 = 0$; and hence this steady state is known as the low equilibrium. On the other hand, when all firms are industrialized ($n_\tau = 1$), the extra consumption is $\nabla C_\tau = \frac{v}{\alpha - v} NL = \frac{\theta}{1-\theta} NL$, which is positive, as $\theta < (1 - 1/\alpha) < 1$ is a necessary condition for a big-push; and hence this steady state is known as the high equilibrium. In summary, the economy enjoys a higher output and consumption by attaining the high equilibrium with full industrialization through a big-push process.

4.3 Kick-start (n_1)

Equation (22) demonstrates that the dynamic path, which is a recursive equation, needs a kick-start in order to initiate a big-push process. Without a kick-start or a big-push, the economy is trapped at low equilibrium. In order to kick-start a big-push process, at least one monopolist firm must industrialize, even though its investment may not be profitable. Simply, $n_1 > 0$ is a necessary condition to launch a big-push process but not sufficient for a successful big-push.

The kick-start fraction (n_1) can influence the time (τ) an economy takes to reach the high equilibrium. The dynamic path equation, Equation (22), shows that the bigger is the push or the kick-start fraction (n_1), the shorter is the time (τ) an economy takes to attain the high equilibrium.

Examples of the prevalent "kick-start" economic policies employed by governments of emerging economies are tax subsidies, incentives on investment, minimum wage policy and etc. For instance, the Singapore government attempted to stimulate industrial upgrading by raising labour costs after 1979 (Rodrik, 1996). The World Bank (1993) reports that the governments of East Asian countries provided producers with subsidies to promote investment and exports, thus pursuing high growth strategies.

4.4 Dynamic Path (n_t)

The dynamic path of big-push is represented by the Equation (22a), which is:

$$n_t = n_{t-1} + (1 - n_{t-1}) \frac{n_{t-1}\theta}{1 - n_{t-1}\theta}$$

where at time $t = 1$, $n_1 > 0$ in order to kick-start a big-push process. Equation (22a) shows that the dynamic path is driven only by θ, the ratio of wage premium on productivity. Simply, an increase in productivity is a necessary but not sufficient condition for industrialization. A big-push process can only be successful if the firms are willing to share their profits with their workers, for example, by paying their workers a wage premium. The higher is the ratio of wage premium on productivity, the higher is the spillover demand which will entice more cottage-firms to industrialize. As a result, the higher is the ratio of wage premium on productivity, the shorter is the time (τ) taken to achieve the high equilibrium ($n_\tau = 1$).

Figure 6 – Equation (22a)

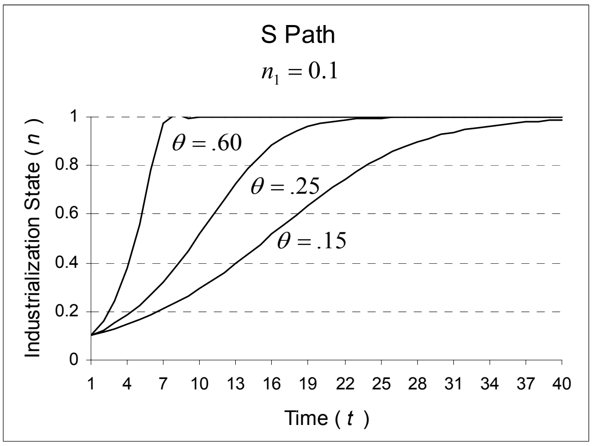


Figure 7 – Equation (22a)

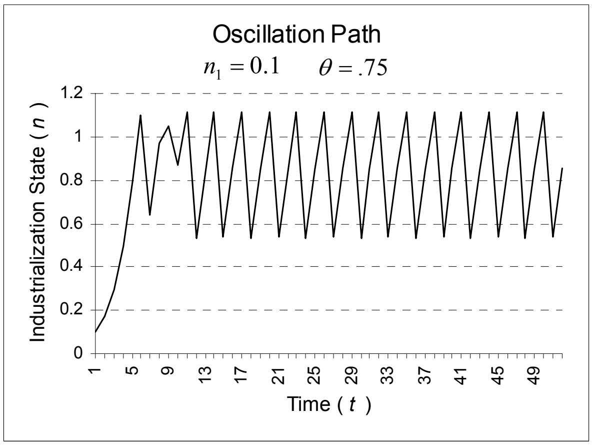


Figure 8 – Equation (22a)

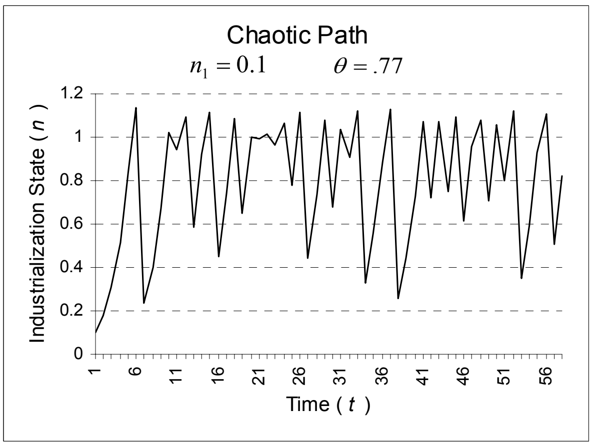
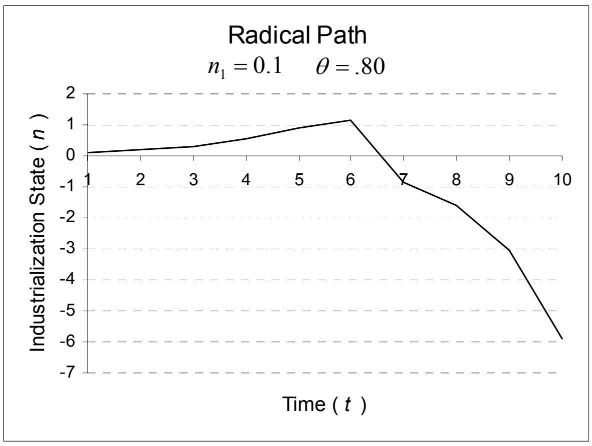


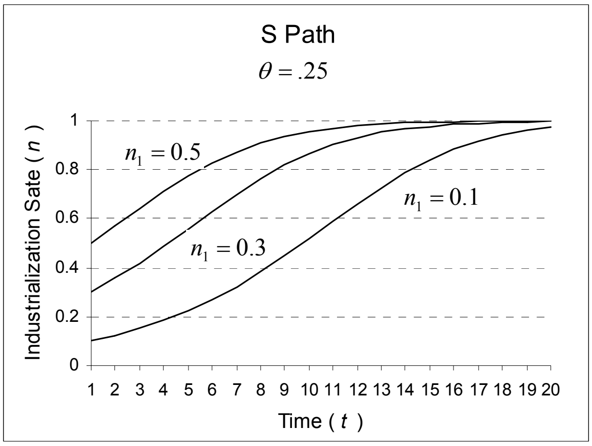
Figure 9 – Equation (22a)



Depending on the value of θ, this model can exhibit one of the following four types of dynamic path: S path (Figure 6), Oscillation path (Figure 7), Chaotic path (Figure 8) and Radical path (Figure 9). Except the S path, the other three dynamic paths have value greater than unity which contravene the condition $0 \le n_t \le 1$.[12] As a result, only the S path is used in the analysis of this model.

Figure 6 shows the plot of n_t against time for different values of θ. The plot exhibits a smooth S-shaped curve, where the dynamic path starts off slowly at the earlier periods, and gains maximum speed in the middle but slows down at the later periods, before reaching the high equilibrium. Figure 10 shows the plots of n_t for different values of n_1 when $\theta = 0.25$. For a higher kick-start fraction, the dynamic path takes a shorter time to attain the high equilibrium. Rather than waiting for the income effect and spillover demand to take effect progressively, the economy receives a jump-start if there are more firms responding to the government's investment incentive. As a result, a more rapid progression to the high equilibrium can be expected.

Figure 10 – Equation (22a)



4.5 High Growth

High growth is one of the key features of a big-push process because of the progressive "synchronization" of industrialization across sectors. The economic growth gains its maximum momentum in the middle of a big-push process where the aggregate spillover demand has its

[12] Leow (2004) offers plausible economic interpretations for the Oscillation, Chaotic and Radical paths, where the value of greater than unity for the industrialization state is interpreted as "over-industrialization". The high ratio of wage premium on productivity drives the economy to grow in chaotic manner, which may lead to a financial crisis.

maximum value. As the output, the consumption and the disposable income are closely interrelated in this model, they exhibit similar high growth behaviour.

4.5.1 Output

While the output of a cottage-firm remains constant at *L*, the output of a technology firm increases with industrialization state according to Equation (3a). The output growth rate of a technology firm is:

$$\%\Delta Y_{T,t} = \frac{\Delta Y_{T,t}}{Y_{T,t-1}} = \frac{Y_{T,t} - Y_{T,t-1}}{Y_{T,t-1}} = \frac{\theta(n_t - n_{t-1})}{1 - n_t\theta} \tag{26}$$

Figure 11 shows that the output of a technology-firm follows an S-shaped curve, and increases with time and industrialization state. With a higher ratio of wage premium on productivity, it increases faster and attains a higher output. Due to the wage premium constraint, i.e. $v < \alpha - 1$, productivity can exert its effects on the output of a technology-firm because a higher ratio of wage premium on productivity is only possible with higher level of productivity. For example, when $\alpha = 2$, the highest possible ratio of wage premium on productivity is 0.5; whereas when $\alpha = 4$, the highest possible ratio of wage premium on productivity is 0.75. Figure 12 shows the plot of output growth rate of a technology-firm is a bell-shaped curve.

Figure 11 – Equation (3a)

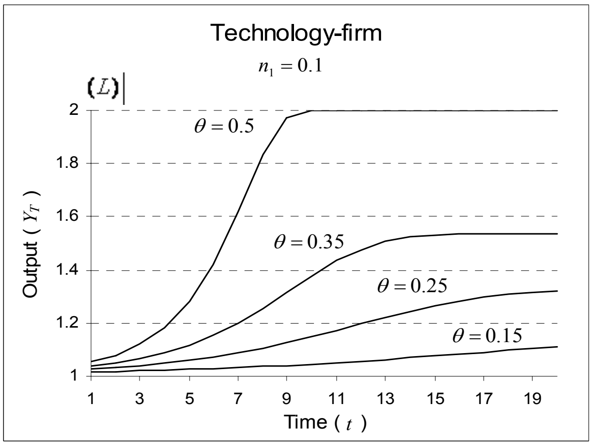
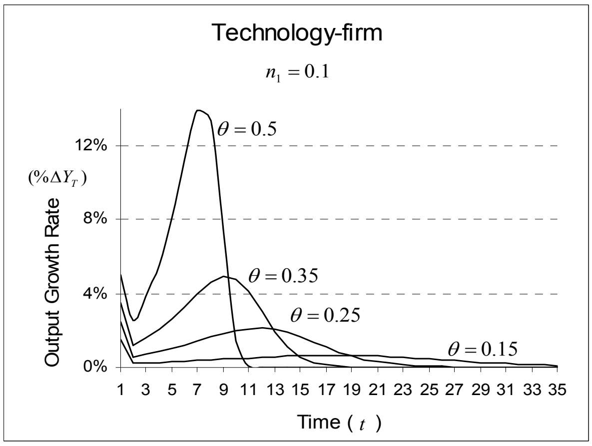


Figure 12 – Equation (26)



Generally, an investment plan has lower sales forecasts at the early periods and then gradually increases the forecasts at the later periods. Although the sales and marketing campaigns are generally attributed to the sales forecasts, this model demonstrates that this is, in fact, the natural outcome of the dynamic path of big-push.

The aggregate output of the group-economy is just the sum of the aggregate output of cottage-firms, i.e. Equation (1) multiplied by $N(1-n_t)$, and that of technology-firms, i.e. Equation (3a) multiplied by Nn_t:

$$\begin{aligned} Y_t &= N(1-n_t)Y_{Ci} + Nn_tY_{Ti,t} \\ &= N(1-n_t)L + Nn_t\alpha\varepsilon_t L \\ &= (1-n_t(1-\alpha\varepsilon_t))NL \end{aligned} \tag{27}$$

At the optimal employment rate, the aggregate output of the group-economy is:

$$Y_t = (1+\frac{n_t^2 v}{\alpha - n_t v})NL = (1+\frac{n_t^2\theta}{1-n_t\theta})NL \tag{27}$$

Figure 13 shows that the aggregate output of the group-economy follows an S-shaped curve, and increases with time and industrialization state. With a higher wage premium, it grows faster and attains a higher output when the economy attains the high equilibrium.

Figure 14 shows that the output growth rate of the group-economy ($\%\Delta Y_t$) is a bell-shaped curve. The bell-shaped growth curves are taller and narrower when the ratio of wage premium on productivity is higher; and flatter and wider when the ratio of wage premium on productivity is lower. With a higher ratio of wage premium on productivity, the economy can achieve a higher growth, which can be sustained above 10% for a number of periods as shown in Figure 14.

Figure 13 – Equation (27a)

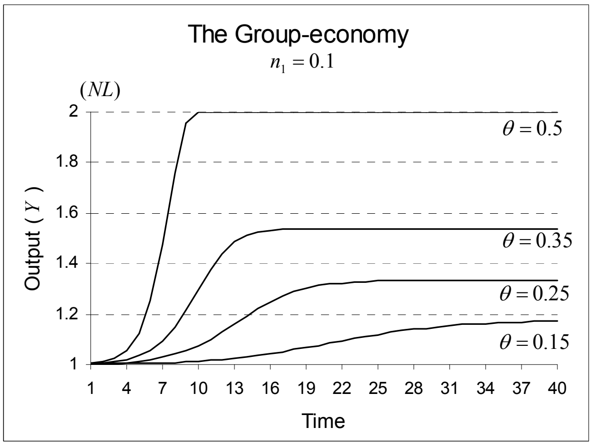
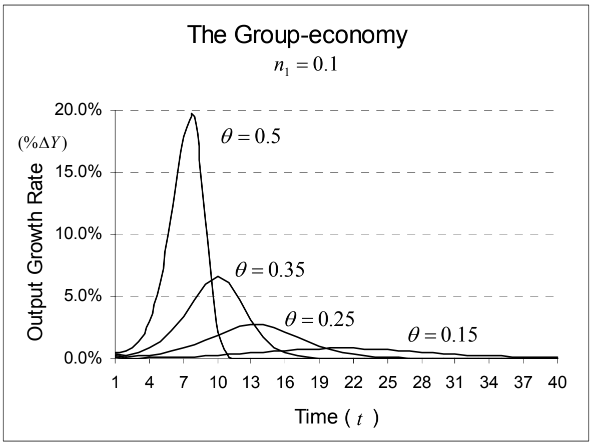


Figure 14 - $\%\Delta Y_t$



A good empirical example of high output growth is the miraculous growth rate in the East Asian economy before the 1997 Asian crisis, as shown in Table 1. “The overall picture is quite clear: in the East Asian countries, GDP growth rates were remarkably high in the 1990s. Growth rates averaging more than 7 percent of GDP (sometimes closer to 10 percent) were the norm.” (Corsetti et al., 1999, pg. 315). In addition, the Chinese economy has a high growth for the past two decades in which it sustained high GDP growth at an average annual rate of 8-9% (IMFSurvey, 2003).

Table 1

	Real GDP Growth				
	Indonesia	Korea	Malaysia	Philippines	Thailand
90-96 Avg	7.3	7.7	8.8	2.8	8.5
1996	8	7.1	8.6	5.7	5.5

Souces: IMF, JP Morgan (See Table 7, Chang and Velasco, 1998)

4.5.2 Consumption

The aggregate consumption of the group-economy is the sum of the aggregate consumption of workers of cottage-firm (Equation (17 multiplied by $N(1-n_t)$), and of technology-firm (Equation (19 multiplied by Nn_t), and the consumption of unemployed workers (Equation (18):

$$\begin{aligned} C_t &= N(1-n_t)C_{Ci,t} + Nn_t C_{Ti,t} + C_{U,t} \\ &= N(1-n_t)L + Nn_t(\varepsilon_t(1+\alpha)-1)L + Nn_t(1-\varepsilon_t)L \quad \text{for} \quad \varepsilon \le \frac{1}{\alpha - n_t v} \\ &= (1+n_t(\alpha\varepsilon_t - 1))NL \end{aligned}$$

$$\begin{aligned} C_t &= N(1-n_t)C_{Ci,t} + Nn_t C_{Ti,t} + C_{U,t} \\ &= N(1-n_t)L + Nn_t(1+n_t v)\varepsilon_t L + Nn_t(1-\varepsilon_t)L \quad \text{for} \quad \varepsilon \ge \frac{1}{\alpha - n_t v} \\ &= (1+n_t^2\varepsilon_t v)NL \end{aligned} \tag{28}$$

At the optimal employment rate, the aggregate consumption of the group-economy is:

$$C_t = (1+\frac{n_t^2\theta}{1-n_t\theta})NL = Y_t \tag{28a}$$

Equation (28a) shows that the aggregate consumption of the group-economy equals the aggregate output of the group-economy. Therefore, the plots of the aggregate consumption and growth rate of consumption of the group-economy ($\%\Delta C_t$) are similar to Figure 13 and Figure 14, with the same S-shaped curve and bell-shaped curve respectively.

4.5.3 Disposable Income

The aggregate disposable income of the group-economy is the sum of the wages of workers of cottage-firms, i.e. Equation (2) multiplied by $N(1-n_t)$, and that of technology-firms, i.e. Equation (4) multiplied by Nn_t, and the unemployment benefits of unemployed workers, i.e. Equation (6):

$$\begin{aligned} W_t &= N(1-n_t)W_{Ci} + Nn_t W_{Ti,t} + W_{U,t} \\ &= N(1-n_t)L + Nn_t(1+v)\varepsilon_t L + Nn_t(1-\varepsilon_t)L \\ &= (1+n_t\varepsilon_t v)NL \end{aligned} \tag{29}$$

At the optimal employment rate, the aggregate disposable income of the group-economy is:

$$W_t = (1+\frac{n_t v}{\alpha - n_t v})NL = (1+\frac{n_t\theta}{1-n_t\theta})NL \tag{29}$$

Figure 15 and Figure 16 show that the aggregate disposable income and growth rate of disposable income ($\%\Delta W_t$) of the group-economy are an S-shaped curve and a bell-shaped curve respectively. Outside the low and high equilibrium, Figure 17 shows that the aggregate disposable income is always higher than the aggregate output because there is a spillover demand for the goods produced by the cottage-firms while the workers of technology-firms have "forced" savings. Compared to the aggregate output or consumption, Figure 18 shows that the disposable income grows at a faster rate at the earlier periods but at slower rate at the later periods.

Figure 15 – Equation (29)

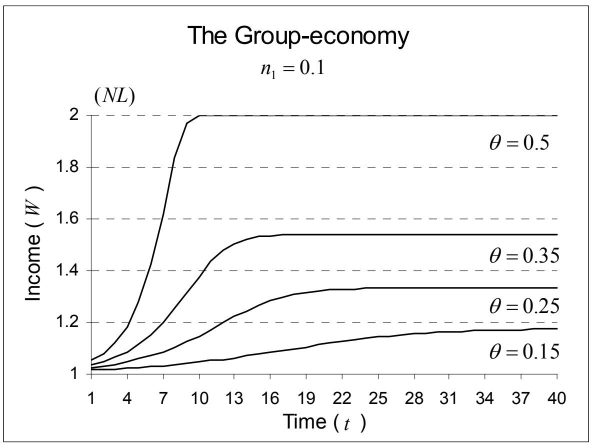


Figure 16 – Income Growth

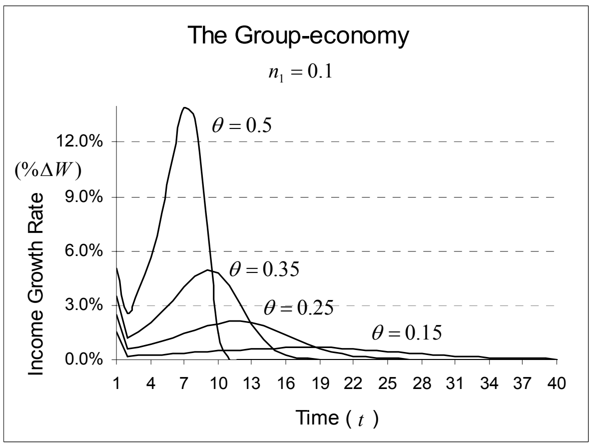


Figure 17 – Equation (27a) & (29)

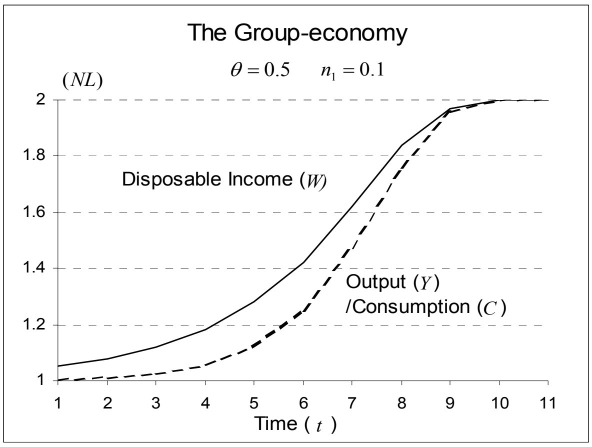
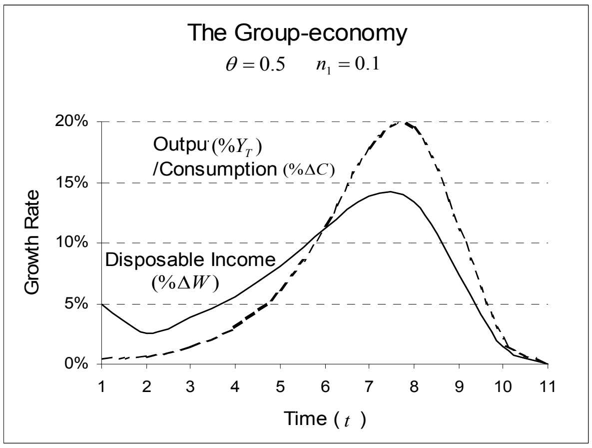
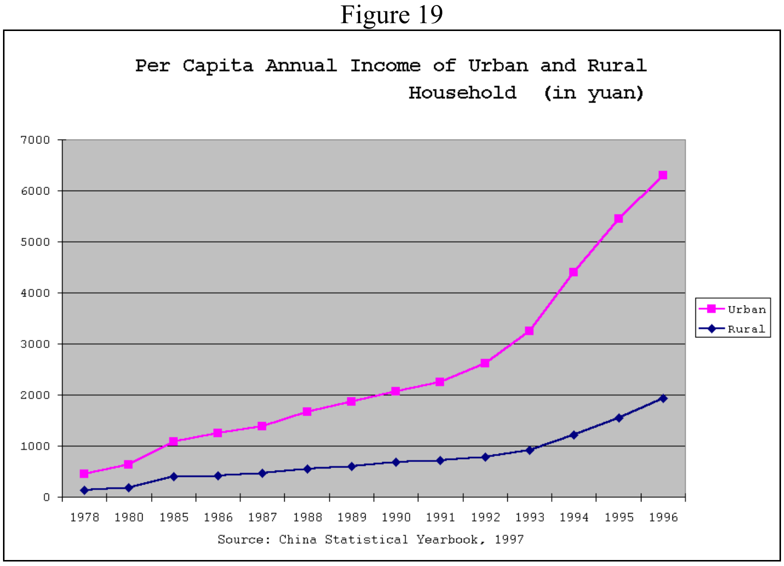


Figure 18 – Output & Income Growth



As shown in Figure 19, there is a close similarity between the initial S-shaped curve shown by the plots of per-capital income of China for rural and urban household, and the S-shaped curve of aggregate disposable income simulated by this model. The fact that the income of urban household increases faster than that of urban household shows that the ratio of wage premium on productivity of urban household is greater than that of the rural household.[13]

Figure 19



Source: China Statistical Yearbook, 1997

4.5.4 High Full-employment Equilibrium

In this model, the growth rate is proportional to the ratio of the wage premium to productivity. Although productivity is an important factor in driving economic growth, this model provides an

[13] This implies a productivity-linked wage system, where the ratio of wage premium over productivity stays approximately the same over time.

understanding that the distribution of productivity gain or wage premium cannot be ignored if a government want to steer an economy towards the high full-employment equilibrium, with maximum output and consumption ($Y_\tau = C_\tau = W_\tau = \alpha NL$) and full employment ($\varepsilon_\tau = 1$).

4.6 Spillover Demand

Equation (13a) shows the spillover demand faced by a cottage-firm during the big-push process. As shown in Figure 20, the spillover demand of a cottage-firm increases with time and industrialization state. It increases faster and reaches a higher value with a higher ratio of wage premium on productivity.

The aggregate spillover demand in the economy equals the spillover demand faced by a cottage-firm multiplied by the number of cottage-firm, i.e. Equation (13a) multiplied by $N(1-n_t)$:

$$D_t = N(1-n_t)D_{Ci,t} = \frac{(1-n_t)n_t\theta}{1-n_t\theta}NL \tag{30}$$

Figure 21 the aggregate spillover demand follows a bell-shaped curve. There is no spillover demand at both the low and high equilibrium. When the wage premium equals the productivity gain, i.e. ($\alpha = 1+v$), the spillover demand reaches a maximum value and exerts its optimum effect on the dynamic path such that the time taken to attain the high equilibrium is the shortest.

Figure 20 – Equation (13a)

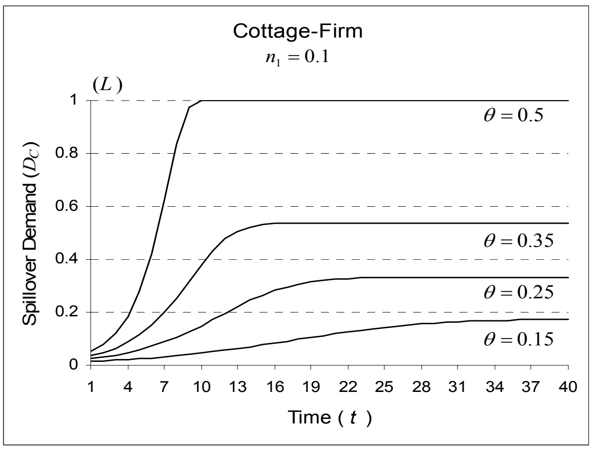
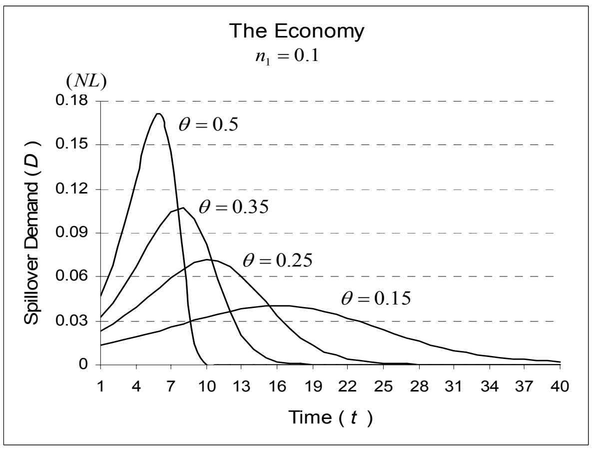


Figure 21 – Equation (30)



4.7 Surplus Inventory

While the cottage-firm faces spillover demand, the technology-firms may face surplus inventory if they produce more than the demand. The period inventory of a technology-firm is as shown in Equation (10).

Figure 22 – Equation (10)

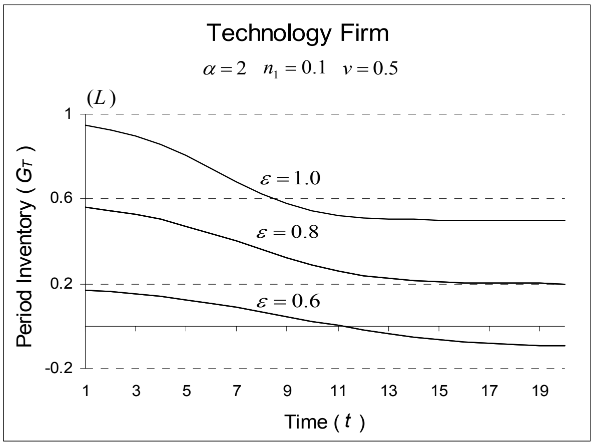
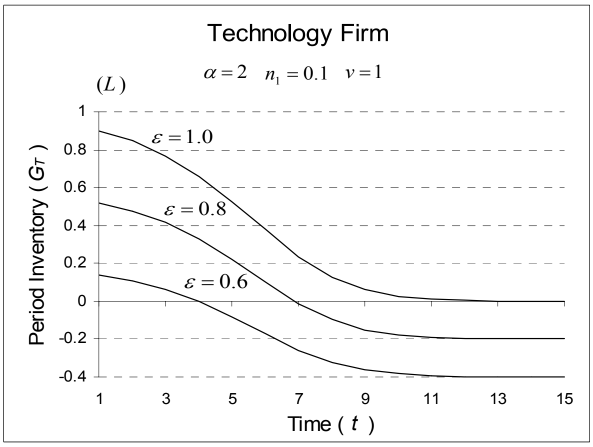


Figure 23 – Equation (10)



For $v = 0.5$ and $\alpha = 2$, Figure 22 shows that the plot of period inventory versus time for various employment rates displays reverse-S curves. For employment rate at 0.8 and 1.0, the period inventory persists after the economy attains the high equilibrium. For an employment rate at 0.6, the period inventory is positive at the initial periods and crosses into the negative at the later periods, indicating that there is "under-employment" because the technology-firm is too conservative in its sales forecast. For $v = 1$ where the wage premium equals the productivity gain, Figure 23 shows similar but steeper reverse-S curves and there is no period inventory at full employment when the economy attains high equilibrium.

In the economy, only the technology-firms may have surplus inventory if their sales forecasts are too aggressive. Therefore the aggregate period inventory of the economy is the period inventory of a technology-firm multiplied by the number of technology-firm, i.e. Equation (10) multiplied by Nn_t:

$$G_t = Nn_t G_{Ti,t} = Nn_t((\alpha - n_t v)\varepsilon_t - 1)L \tag{31}$$

Figure 24 - Equation (31)

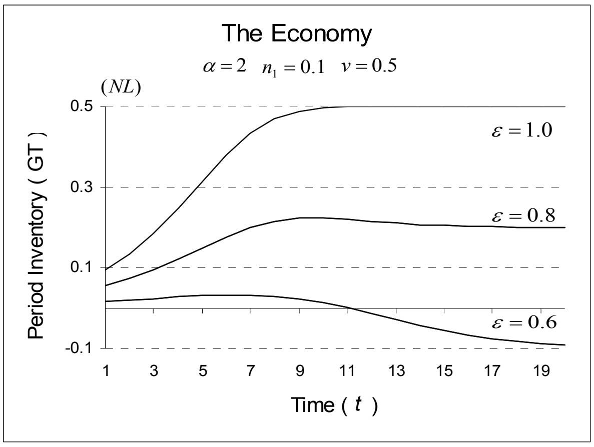
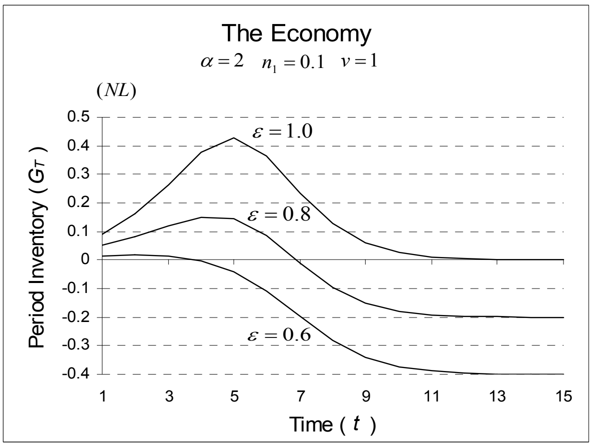


Figure 25 – Equation (31)



For $v = 0.5$, Figure 24 shows that the plots of period inventory against time displays an S-shaped curve with high employment rate ($\varepsilon = 0.8$ or $\varepsilon = 1$) but reversed-S-shaped curve with a low employment rate ($\varepsilon = 0.6$). For $v = 1$, when wage premium equals the productivity gain, Figure 25 shows that the plots of period inventory against time are bell-shaped with high employment rate ($\varepsilon = 1$) but reversed-S curves with low employment rate ($\varepsilon = 0.6$ or $\varepsilon = 0.8$). There is also no period inventory at full employment when the economy attains high equilibrium.

Facing surplus inventory, a technology-firm can take one of the following actions:

i. *Reduce Production*

The technology-firm can be more conservative in its sales forecast and cut back its production by decreasing the employment rate. Reduction in production can mean surplus capacity if the investment is lumpy. Since the capital and material cost are not included in the production function, this model cannot simulate the loss of capital opportunity due to under-utilization of production capacity. Large infrastructure projects are good examples of lumpiness in investment. Infrastructure such as an airport will not be built without enough potential industrial customers. On the other hand, without the infrastructure, industrialization will not take place. It is not uncommon to have infrastructure with low utilization or surplus capacity at the initial periods because infrastructure is usually a long-term investment. In the emerging economies, examples of excess capacities which are commonly blamed for tilting the economy towards financial crises are commercial property such as vacant office spaces, and the under-utilized infrastructures such as big airports.

ii. Decrease Price

The technology-firm can drop the price in order to clear its surplus inventory. Facing a unitary elastic demand curve, this may not be a practical option because lowering the price does not increase the firm's revenue.

iii. Export Goods

Since the goods are assumed to be perishable and ruined at the next period, surplus inventory is just wastage when the technology-firm is not able to find a market to dispose them within the current period. However, for non-perishable goods, the surplus inventory can be stored to fulfil future demand by reducing the output for the next period. There is a domestic pressure to export the surplus inventory if there are foreign economies which can absorb the surplus inventory. In this case, the foreign economies may be embraced into the big-push process.[14] Theoretically, exports will not interfere with the big-push process, and can accelerate the pace of big-push unless exports compete with domestic demand. In this model, the surplus inventory is always the excess supply of a collection of goods for which there is no domestic demand. Generally, stimulating economic growth by encouraging export provides the following advantages to a big-push process:

- It reduces unemployment and hence the government can save the outlay of unemployment benefits;
- Firms can afford to pay higher wage premiums, which stimulate faster growth towards high equilibrium;
- It reduces the foreign debts, capital inflow and account deficit of emerging economies.

4.8 Unemployment

As shown in Equation (5), the unemployment rate of the group-economy is $U_t = n_t(1-\varepsilon_t)$. At the optimal employment rate, the unemployment rate of the group-economy is:

$$U_t = \frac{(\alpha - 1 - nv)n_t}{\alpha - n_t v} = \frac{(\gamma - n_t\theta)n_t}{1 - n_t\theta} \qquad \text{(5a)}$$

[14] Using similar principle, this model can be extended to study a big-push process involving two or more economies. This may be used to explain the cross-country contagion effect of financial crisis.

Figure 26 – Equation (5a)

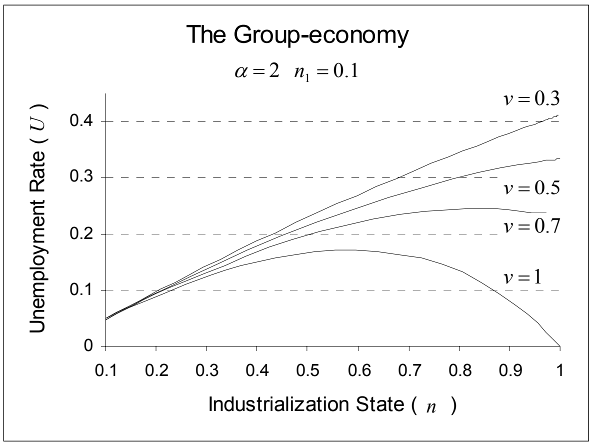


Figure 27– Equation (5a)

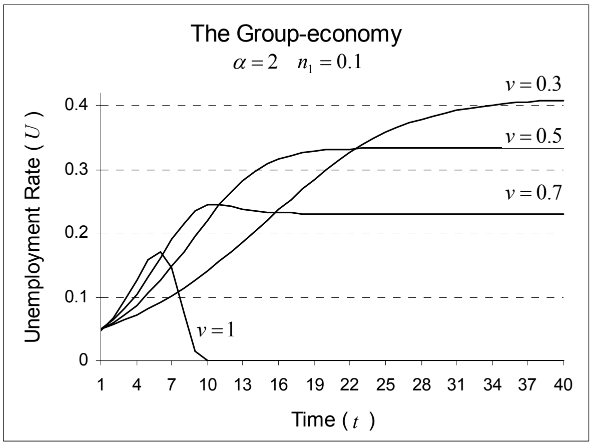


Figure 26 and Figure 27 show the plots of the unemployment rate of the group-economy against the industrialization state and time respectively. For a given level of productivity, the unemployment rate decreases with wage premium. When the wage premium equals the productivity gain, $v = \alpha - 1$, the plot show a bell-shaped curve. The unemployment rate decreases to zero when the full industrialization is attained.

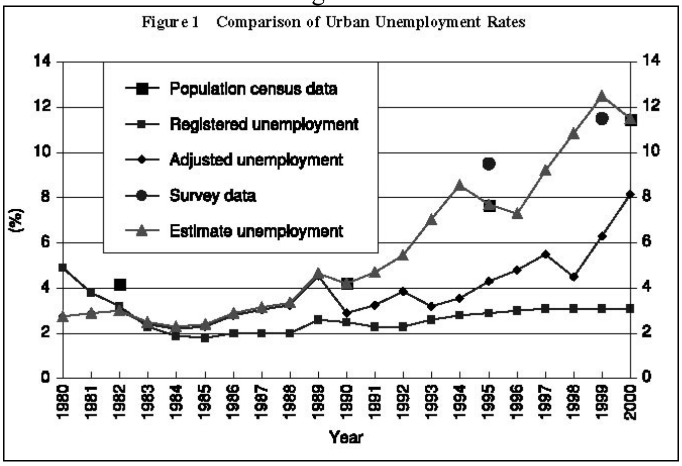
When the wage premium is less than the productivity gain, the unemployment rate persists at the $(\alpha - 1 - v)/(\alpha - v)$ level after the economy attains the high equilibrium. In another words, the economy fails to reach full employment at high equilibrium when the wage premium is less than the productivity gain. This is a sub-optimal high equilibrium because there are still unemployed workers collecting unemployment benefits which is less than the disposable income of a employed worker, $(1 + v)$. However, the technology-firm cannot afford to pay a wage premium equal to the productivity gain ($v = \alpha - 1$) unless the new technology is free ($F = 0$). Nevertheless, the high full-employment equilibrium can be recovered if the technology-firms pay a wage premium equal to the productivity gain after clearing their debts borrowed to invest in the new technology.[15]

In conclusion, there is an incentive for a government to push for the high full-employment equilibrium by encouraging the firms to share their profits by paying their workers a maximum

[15] Without an unemployment benefit system, small-service labour-intensive industry may sprout in an emerging economy. This small-service industry may develop into a tertiary service industry when the economy becomes developed when the employment rate (ε) does not recover to full employment.

wage premium. Alternatively, the government can enforce a productivity-linked wage system to compliment the big-push process.

Figure 28



Source: See Xue and Zhong, 2003

Xue and Zhong (2003) attempted to estimate the real urban unemployment rate in China. As shown in Figure 28, the plots of the adjusted and estimated urban unemployment rate from 1980 to 2000 follow the familiar curves as shown in Figure 27.

4.8.1 Unemployment Benefit

Equation (6) shows the cost to government in maintaining unemployment benefits. At the optimum employment rate, the aggregate unemployment benefit is:

$$W_{U,t} = \frac{(\alpha - 1 - n_t v)n_t}{\alpha - n_t v} NL = \frac{(\gamma - n_t \theta)n_t}{1 - n_t \theta} NL \tag{6a}$$

As $w_u = 1$, the plots of unemployment benefits against industrialization state and time are similar to those in Figure 26 and Figure 27. On one hand, the technology-firm wants to minimize the financial burden of its debt by paying the minimum wage premium; on the other hand, the government wants to minimise the unemployment by encouraging the technology-firms to pay the maximum wage premium.

When the wage premium is less than the productivity gain, even if the government is able to tax all the "forced" savings of workers of technology-firm, it still needs to cope with the minimum cost of unemployment benefits, which is the difference between the unemployment benefits and savings, i.e. Equation (6a) minus Equation (34):

$$W_{U,t} - S_t = \frac{(\alpha - 1 - n_t v)n_t}{\alpha - n_t v} NL - \frac{(1-n_t)n_t\theta}{1-n_t\theta} NL = \frac{(\alpha - 1 - v)n_t}{\alpha - n_t v} NL = \frac{(\gamma - \theta)n_t}{1-n_t\theta} NL$$

Considering the welfare of the economy by minimising the aggregate debts of technology-firms and the cost of unemployment benefits of the government, the optimum wage premium can be shown to be half of the productivity gain if the technology-firms increase the wage premiums to the value of the productivity gain after their debts are cleared.

4.9 Income Inequality

In this model, there are three tiers income structure, which are (1) the workers of cottage-firm, (2) the workers of technology-firm, and (3) the unemployed workers. Since the workers of technology-firm receive a wage premium, they have comparatively higher disposable incomes, and hence higher consumption and period savings. As a result, income inequality evolves as time and industrialization state progress. The dynamic behaviours of disposable income, period savings and Gini coefficient are discussed in Section 4.9.1, 4.9.2 and 4.9.3 respectively.

4.9.1 Disposable Income

Compared to a cottage-firm worker, each technology-firm worker has an extra disposable income of v. Therefore the extra disposable income of workers in a technology-firm equals the wage premium multiplied by the number of employed workers in a technology-firms, i.e v multiplied by $\varepsilon_t L$:

$$\nabla W_{Ti,t} = \varepsilon_t vL \tag{32}$$

At the optimal employment rate, the extra disposable income of workers of a technology-firm is:

$$\nabla W_{Ti,t} = \varepsilon_t vL = \frac{v}{\alpha - n_t v} L = \frac{\theta}{1-n_t\theta} L \tag{32a}$$

Multiplied Equation (32a) by the number of technology-firm (Nn_t), the aggregate extra disposable income of the economy is:

$$\nabla W_t = Nn_t \nabla W_{Ti,t} = Nn_t \varepsilon_t vL = \frac{n_t v}{\alpha - n_t v} NL = \frac{n_t \theta}{1 - n_t \theta} NL \tag{33}$$

Figure 29 – Equation (33)

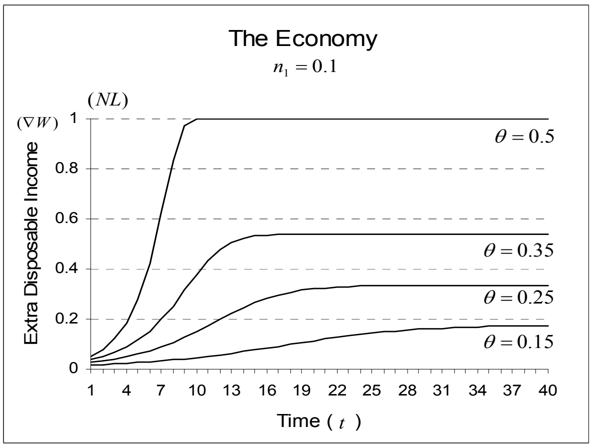
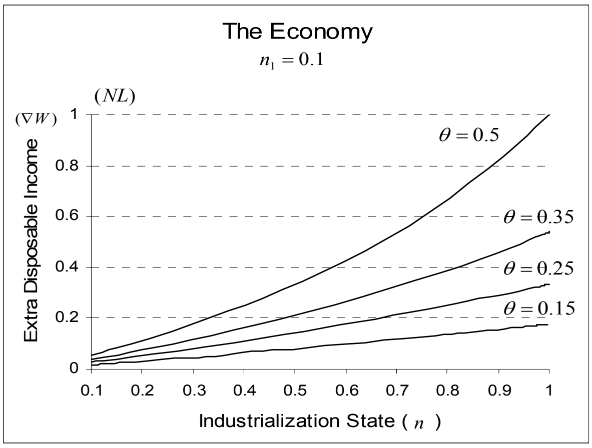


Figure 30 – Equation (33)

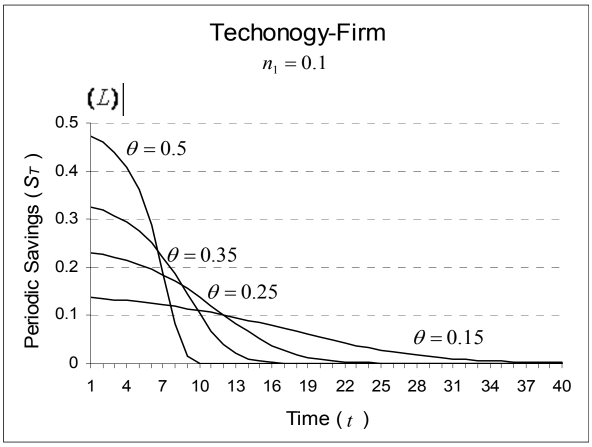


As shown in Figure 29 and Figure 30, the extra disposable income is always positive and increases with the industrialization state, reaching a maximum value at the high equilibrium,. With a higher wage premium, the extra disposable income increases faster and reaches a higher value.

4.9.2 Savings

Besides having higher consumption, the workers of technology-firm have period savings as shown in Equation (16a). Figure 31 shows the plots of the period saving of a technology-firm against time. At the kick-start of big-push process, the period savings are at a maximum and then decrease with time until the period savings disappear when the high equilibrium is attained. At the early states of big-push, the period savings are high but the number of technology-firm is small. Consequently, there is small number of workers of technology-firm who earn higher income than the workers of cottage-firm. Besides enjoying higher consumption than those workers of cottage-firm, the workers of technology-firm have 'forced' savings because the right collection of domestic goods (produced by cottage-firms) is in short supply. With a higher ratio of wage premium on productivity, the period savings have a higher maximum value but decreases at a faster rate with time.

Figure 31 – Equation (16a)



Since the workers of cottage-firm do not have savings, the aggregate period savings of the economy is the period savings of a technology-firm multiplied by the number of technology-firm, i.e. Equation (16a) multiplied by Nn_t: [16]

$$S_t = Nn_t S_{Ti,t} = \frac{(1-n_t)n_t v}{\alpha - n_t v} NL = \frac{(1-n_t)n_t \theta}{1-n_t\theta} NL = D_t \tag{34}$$

As Equation (34) is the same as Equation (29), the period savings of the economy is the same as the spillover demand of the economy because the period savings are the "forced savings" due to the unfulfilled spillover demand. Thus, the plot of aggregate period savings of the economy against time follows a bell-shaped curve as shown in Figure 21.

Chang and Velasco (1998, pg. 13) assert, "The Asean-5 countries saved a lot, and invested even more. Correspondingly, their current accounts were generally in deficit". Asian countries were characterised by very high savings rates throughout 1990s (Corsetti et al., 1999). The savings over GDP ratios for the Asean-5 countries range from 22.7% in Philippines to 40.6% in Malaysia as shown in Table 2.

Table 2

	Savings/GDP				
	Indonesia	Korea	Malaysia	Philippines	Thailand
90-96 Avg	28.4	35.4	34.6	19.1	28.6
1996	30.6	33.9	40.6	22.7	31.5

Souces: IMF, JP Morgan (See Table 7, Chang and Velasco, 1998)

[16] The jobless workers may use their savings to maintain their livelihood. This will have a negative impact on the aggregate savings of the economy.

4.9.3 Gini Coefficients

Lorenz curve and Gini Coefficients are common and effective ways of showing the inequality of income. Knowing that there are $Nn_t(1-\varepsilon_t)L$ unemployed workers receiving an unemployment benefit of $w_u = 1$, $N(1-n_t)L$ workers of cottage-firm receiving an income of $w_{Ci} = 1$, and $Nn_t\varepsilon_t L$ workers of technology-firm receiving an income of $w_{Ti} = (1+v)$, the Gini Coefficient of the group-economy is:

$$GC = \frac{n_t\varepsilon_t v(1-n\varepsilon_t)}{1+n_t\varepsilon_t v} \tag{35}$$

Figure 32 and Figure 33 shows the plots of Gini Coefficients against the industrialization state and against time respectively. When the wage premium equals to productivity gain, $\alpha = 1+v$, the inverted-U or bell-shaped curve displays a good match with the Kuznets (1955) curve, whereby inequality first increases then decreases during the process of economic development. This model encompasses the same principle as that behind the Kuznets Curve. The workers of technology-firm experience a rise in income and this change raises the economy's overall degree of inequality. Initially the dominant effect is the expansion in size of the small and relatively rich group of workers of technology-firm.

Figure 32 – Equation (35)

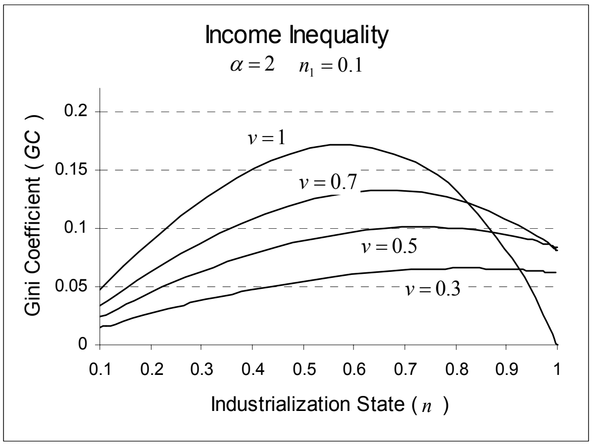
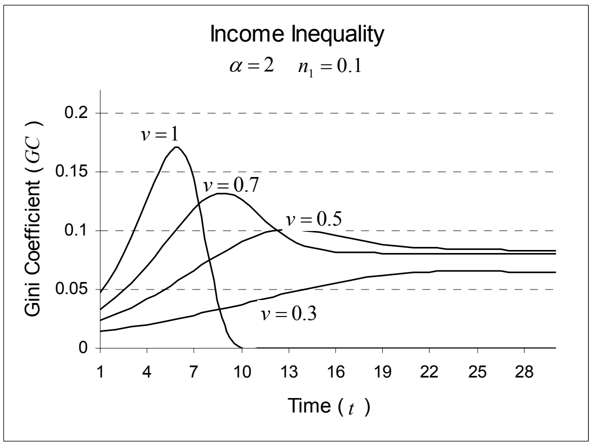
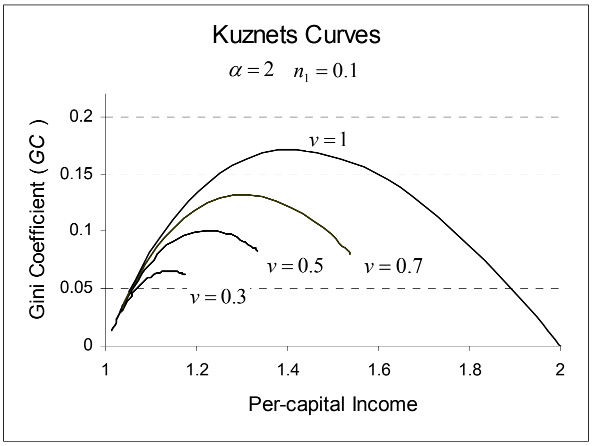


Figure 33 – Equation (35)



When the wage premium is less than the productivity gain, $\alpha < 1+v$, the inverted-U curve stops short of reaching zero at high equilibrium, when $n_\tau = 1$. As the Gini coefficient is higher than zero, the inequality persists because the economy fails to achieve full employment ($\varepsilon_\tau < 1$) after attaining the high equilibrium.

Figure 34



As shown in Figure 34, at the early stage of big-push, the relationship between the level of per capital income and the extent of inequality tends to be positive. As the number of cottage-firm diminishes, the main effect on inequality from the continuing industrialization is that more of the unemployed and poor workers of cottage-firm are able to join the relatively rich workers of technology-firm. Many workers of technology-firm who started out at the bottom rungs tend to move up in relation to the richer workers. The decreasing size of the unemployed workers and the labour force of cottage-firm tend to drive up relative wages. This combination of forces reduces the overall inequality. Hence, at later stages of big-push, the relation between the level of per capital income and the extent of inequality tends to be negative. As a result, the full relationship between the Gini coefficient and the level of per-capital income is an inverted-U as shown in Figure 34.

The World Bank (1997a) pointed out that even in East Asia including the four 'tigers', inequality is becoming more widespread, despite their successes in pulling millions of people out of poverty line. The report emphasizes the growing gap in earning power between skilled and unskilled workers in increasingly sophisticated economies. In China, both rural and urban inequality increased steadily between 1981 and 1995, where the urban Gini coefficient increased from 0.176 in 1981 to 0.275 in 1995 and the rural Gini coefficient increase from 0.242 in 1981 to 0.333 in 1995 (World Bank, 1977b). In fact, the 'miraculous' phenomenon of entrepreneurs turning into 'instant millionaires'[17] is not uncommon in the emerging economies with rapid growth.

[17] "While it is part of the largely neglected southwest region of China, which receives little of the investment pumped in to the east coast, it boats its own breed of entrepreneur. One such man is Mr. Yin, who has become an almost instant millionaire at the age of 60." (BBC News, 2002).

4.9.4 Import Consumption

Due to the spillover demand by the workers of technology-firm, there is a compelling pressure on the domestic economy to import the goods to fulfil the spillover demand if foreign economies can supply the right collection of goods. Moreover, the income disparity encourages differentiated consumption behaviour, where the affluent workers may desire to consume superior goods.

Theoretically, importing goods to meet the domestic spillover demand will not interfere with the big-push process as long as the imported goods do not compete with domestic goods. As more and more cottage-firms industrialized with time, the domestic economy increases its output attempting to satisfy the spillover demand. However, if the differentiated consumption behaviour becomes entrenched and the import replacement refuses to take place, this inevitably will hinder or even reverse the progress of the big-push process. Burton (1955, pg 336) asserted, “Controls that reduce consumer imports may be necessary to change the pattern of consumption or to gain time until domestic output can be increased.”

There are two ways the government can discourage import consumption: (1) investment and (2) tax. Firstly, the government can encourage the workers to invest their savings. If the population is generally not proficient or active in investment activity, or the domestic stock market is underdeveloped, the government can impose some kind of “forced” savings that can be used collectively as investment funds. For example, the Singapore government implemented the Central Providence Fund, which the government deploys as investment funds for government or commercial projects. If the workers of technology-firm invest their savings in the equity market, then the technology-firms can secure investment funds through a combination of equity and debt financing. The apparent advantages to the economy are:

- Discouragement of import consumption;
- Reduction of unnecessary capital inflow;
- Generation of more spillover demand from dividends as part of increased disposable incomes.

However, encouraging investment may overheat the stock and property markets. Due to high sustaining growth and strong economic indicators, share and property prices can be bid beyond the fundamental values, leading to an asset bubble in the economy. When the fragility of big push strikes, the asset bubble bursts. As a result, financial crises are mostly associated with a collapse in asset prices.

Secondly, the government can impose higher taxes on the higher incomes of workers of technology-firm. Instead of import consumption, which can be detrimental to the domestic economy, the savings taxed can contribute toward the unemployment benefits, thus alleviating the financial burden on the government. However, since a wage premium of v is necessary to entice workers to work in a technology-firm, higher taxes may have an adverse effect of discouraging workers to work in a technology-firm. Alternatively, the workers may demand even higher wage premiums with which the firms may find the investments are no longer profitable. As a result, high taxes may in fact reverse the process of big-push.

4.10 Debt and Capital Flow

As a technology-firm takes a loan of B to invest in the new IRS technology at period $t1$, the debt of a technology-firm at time t is just the loan plus the interest minus the aggregate repayments, which are the firm's operating profits, $\Pi_{Ti,t}$, i.e. Equation (15), plus interest:

$$\begin{aligned} B_{TI,t} &= B(1+r)^{t-t1} - \sum_{j=t1+1}^{t} \Pi_{Ti,j}(1+r)^{t-j} \\ &= B(1+r)^{t-t1} - \sum_{j=t1+1}^{t} [\varepsilon_t(\alpha - 1 - v)](1+r)^{t-j} \qquad \text{for } \varepsilon_t \geq 1/\alpha - n_t v \\ &= B(1+r)^{t-t1} - \sum_{j=t1+1}^{t} [1 + \varepsilon_t(v(n_t - 1) - 1](1+r)^{t-j} \qquad \text{for } \varepsilon_t \leq 1/\alpha - n_t v \end{aligned} \tag{36}$$

where $t \geq t1$.

When $t = t1$, $B_{Ti,t1} = B$. At the optimal employment rate, the debt of a technology-firm is:

$$B_{TI,t} = B(1+r)^{t-t1} - \sum_{j=t1+1}^{t} \frac{(\gamma - \theta)L}{(1 - n_t\theta)}(1+r)^{t-j} \tag{36a}$$

Figure 35 shows that the plot of operating profit of a technology-firm against time displays S-shaped curves. The higher is the wage premium, the lower is the operating profit because the labour cost increases as wage premium increases.

Figure 35 – Equation (15a)

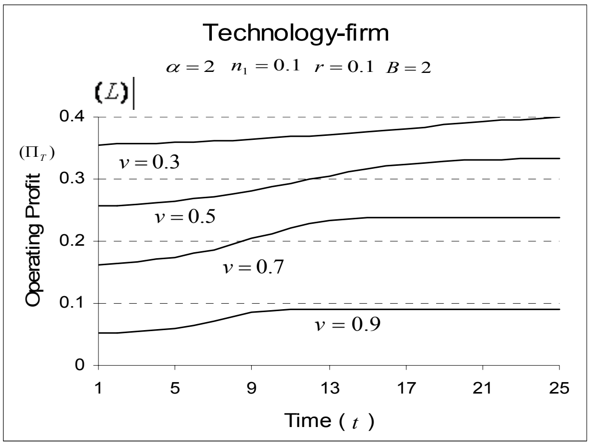


Figure 36 – Equation (36a)

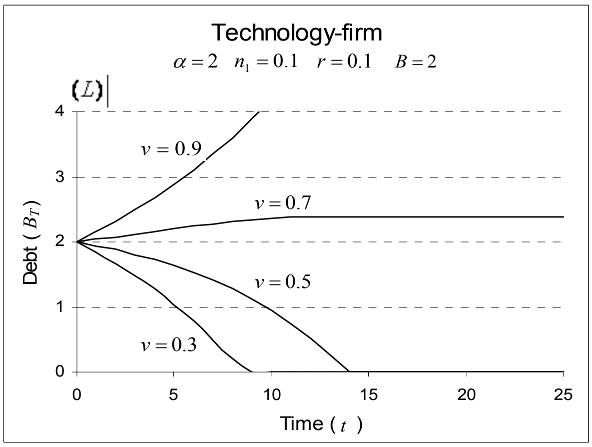


Figure 36 shows the plots of debt of a technology-firm versus time for $B = 2$ at $t = 0$. For $v = 0.3$ or $v = 0.5$, the debt decreases exponentially to zero but it decreases faster for $v = 0.3$. In the case of $v = 0.7$ or $v = 0.9$, the debt increases with time but is faster for $v = 0.9$, and the technology-firm can never pay back the loan because the cost of capital is more than the firm's operating profit. Simply, for $\alpha = 2$, $B = 2$ and $r = 0.1$, the technology-firm will not industrialize if it has to pay a wage premium of $v = 0.7$ or more to entice the workers to work in a industrial environment.

The aggregate debt of the economy at period t is the sum of debts of technology-firms which industrialize at any period between $t1 = 0$ to $t1 = t$:

$$B_t = \sum_{t1=0}^{t} N(n_{t1+1} - n_{t1}) B_{Ti,t1} = \sum_{t1=0}^{t} \left[N\left(n_{t1+1} - n_{t1}\right) \left(B(1+r)^{t-t1} - \sum_{j=t1+1}^{t} \Pi_{Ti,j} (1+r)^{t-j} \right) \right] \quad (37)$$

Figure 37 – Equation (37)

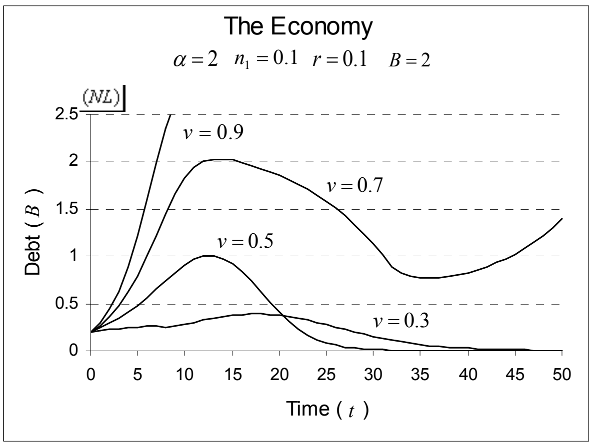


Figure 38 - Equation (37)

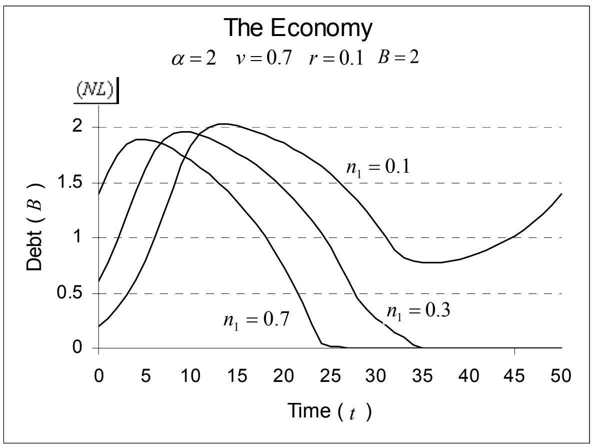


Figure 37 shows that the plots of aggregate debt of the economy exhibit bell-shaped curves. The higher is the wage premium, the higher is the aggregate debt that increases or decreases faster with a higher wage premium. Figure 38 shows that kick-start fraction does not have a significant effect on the magnitude of aggregate debt, except aggregate debt increases and decreases slightly faster with a higher kick-start fraction.

For $v = 0.7$ or $v = 0.9$ and $n_1 = 0.1$, Figure 37 shows that the economy could not clear the debt as the debt is accumulating. In particular, the debt curve for $v = 0.7$ shows that while the decreasing debts from $t = 14$ to 38 may give the government a false signal that the aggregate debt of the economy is in control, the aggregate debt can suddenly run out of control as the economy can no longer sustain the cost of capital after $t = 39$. Hence, a declining debt structure does not imply a healthy underlying debt structure. With imperfection knowledge of complementarity, an economy that embarks on a big-push process in these conditions will head toward high unsustainable debts, which will eventually lead to the collapse of the economy or a financial crisis.

Table 3 – Debt before the Asia '97 Crisis

	Total (US$ million)				
	Indonesia	Korea	Malaysia	Philippines	Thailand
Jun-90	20,076	23,369	6,864	9,055	11,675
Jun-94	30,902	48,132	13,874	5,990	36,545
Jun-97	58,726	103,432	28,820	14,115	69,382

Sources: Bank of International Settlements
(See Table 15, Chang and Velasco,1998)

Table 4 Foreign Debts

	Foreign Debt (% of GDP)				
	Indonesia	Korea	Malaysia	Philippines	Thailand
1990	65.89	13.79	35.80	69.02	32.80
1991	68.21	13.51	35.48	71.45	38.38
1992	68.74	14.34	34.51	62.29	37.51
1993	56.44	14.18	40.74	66.09	34.10
1994	60.96	14.32	40.40	62.42	33.31
1995	61.54	23.80	39.31	53.21	33.78
1996	56.74	28.40	40.06	49.75	50.05

Sources: World Bank Data (See Table 23, Corsetti e. al., 1999)

Since emerging economies are in the middle of industrialization and the developed economies are at industrialization states near to the high equilibrium, Figure 37 shows that the emerging economies accumulate debts while the developed economies either have decreasing debts or no debt at the high equilibrium. The accumulation of debts is one of the key reasons why the emerging economies are more susceptible to financial crisis compared to the developed economies. High debt is a common phenomenon in the emerging economies, for example, the five Asian countries accumulated very high debts and foreign debts before the Asia '97 crisis as shown in Table 3 and Table 4.

Figure 39 – Equation (37) vs $\%\Delta Y_t$

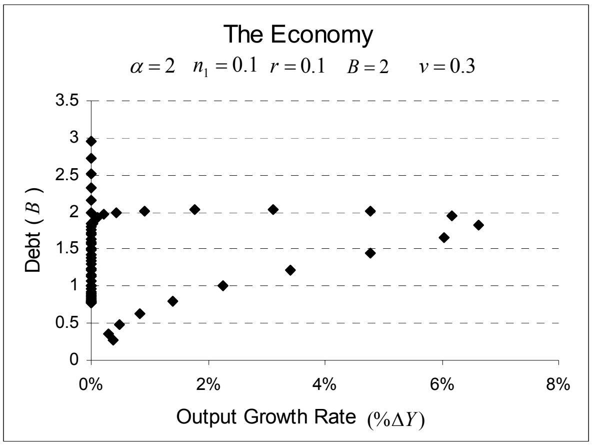


Figure 40 – Equation (37) & $\%\Delta Y_t$

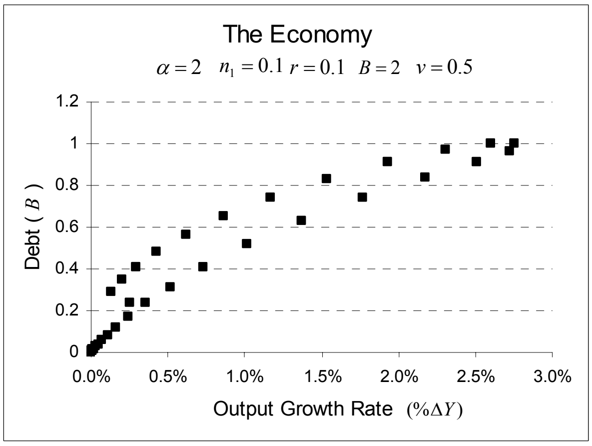


Figure 41– Equation (37) vs $\%\Delta Y_t$

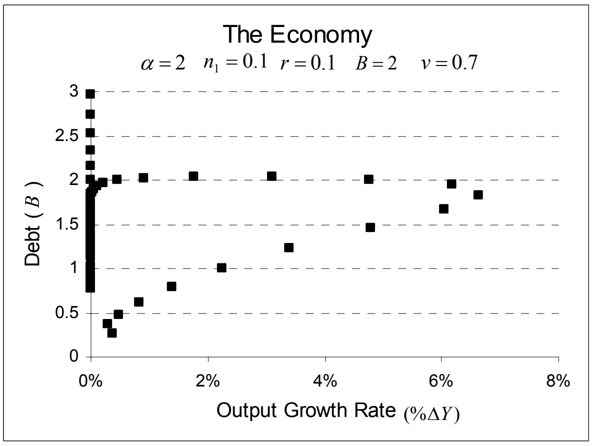


Figure 42– Equation (37) vs $\%\Delta Y_t$

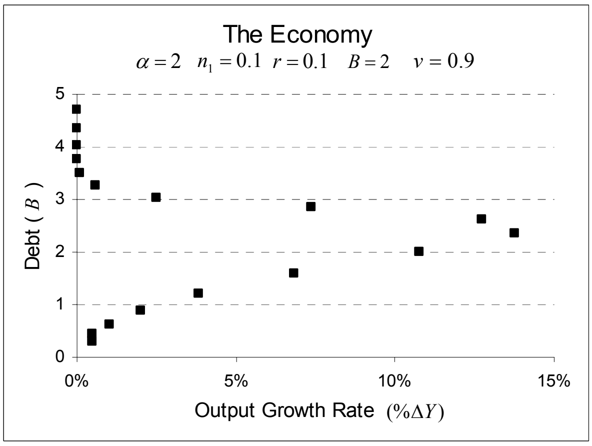


Figure 39 to Figure 42 show the plots of aggregate debt against output growth rate for various wage premiums. Although it generally increases with output growth rate, the aggregate debt may remain constant or even decrease with output growth rate. In the other words, there is a positive relationship between aggregate debt and growth rate of the economy, in general, without ruling out the possibility of a negative relationship.

4.10.1 Capital Inflow

At the initial states of big-push, the growing investment activity increases the demand for investment fund increases. If the domestic economy is not capable of supplying its own investment funds or its cost of capital is higher than that of the foreign economies, then the firms will borrow from foreign economies, resulting in a capital flow into the domestic economy. Without government's control of capital inflow, big-push inevitably triggers a huge increase in capital inflow at the initial states. If all the technology-firms borrow from foreign banks, then the capital inflow of the economy at each period is just the difference between the debt of current period and that of the previous period:

$$CI_t = B_t - B_{t-1} \tag{38}$$

Figure 43 and Figure 44 shows the plots of capital inflow against time and industrialization state respectively. In Figure 43, for $v = 0.5$, the capital inflow displays a sine wave curve where there is a positive capital inflow at the earlier periods and then negative capital inflow or capital outflow at later periods; and it eventually settles at zero when the debt is cleared. Apparently, for $v = 0.9$, the economy could not afford the debt and hence there is a continuous capital inflow to sustain debt as the economy heads toward an economic calamity. The higher is the wage premium, the higher is the capital inflow. In Figure 44, while the capital outflow starts at about $n_t = 0.6$ for $v = 0.3$, capital outflow only starts when the economy is near to full industrialization for $v = 0.5$, because the path to full industrialization is faster with a higher wage premium.

Although the government wants the economy to reach high equilibrium quickly so as to reduce the burden of unemployment, the high capital inflow shows up as large current account deficit which is usually perceived as a negative economic indicator. The increasing debt and capital inflow are familiar economic phenomena in emerging economies. Before the 1997 currency crisis, countries in South East Asia had high debt and high capital inflow while the economies were enjoying high growth.

Figure 43 – Equation (38)

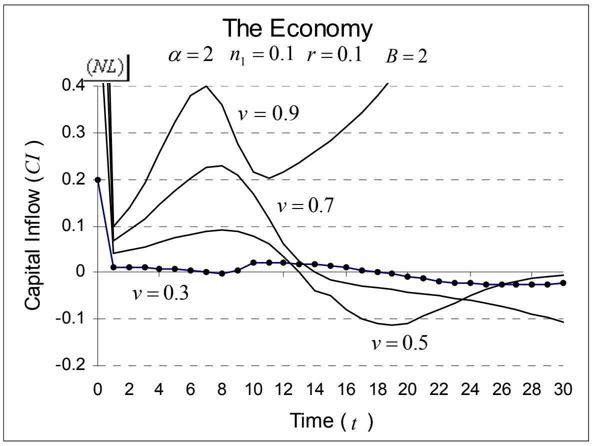


Figure 44 – Equation (38)

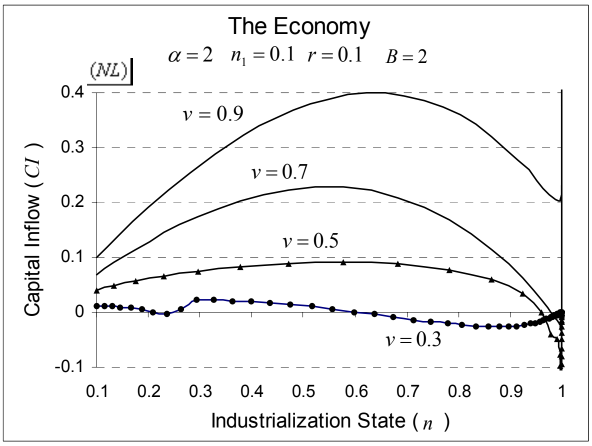


Table 5

	% Total Liabilities			
	Japan		U.S.	
	June 1994	Dec 1996	June 1994	Dec 1996
Asia Average	37.2	30.1	12.8	12.2
China	29.5	32.3	1.9	4.9
Indonesia	54.0	39.7	7.7	9.5
Korea	29.4	24.3	10.0	9.4
Malaysia	40.2	36.9	11.3	10.5
Philippines	17.2	11.7	39.4	29.4
Thailand	56.8	53.5	7.1	7.2
Latin America Average	7.1	5.2	28.8	26.3
Argentina	5.3	4.0	31.2	29.5
Brazil	10.6	7.6	22.7	27.1
Chile	8.8	5.2	31.2	27.9
Colombia	13.0	7.8	26.6	24.6
Mexico	7.3	8.7	34.2	28.4
Peru	7.5	2.9	15.9	17.4
Uruguay	0.7	0.8	35.2	30.2
Venezuela	3.7	4.2	33.3	25.6

Sources: Bank of International Settlements
(See Table 4, Kaminsky and Reinhart, 2000)

If the emerging economies are in the middle states of industrialization, then the developed economies are at the industrialization states near to the high equilibrium or even trapped at high equilibrium, such as the stagnation of the Japanese economy in 1990s. The emerging economies need a high capital inflow to meet the high demand for investment funds that are typically supplied by the high capital outflow of the industrialized economies. For example, most of the Asian countries depend heavily on Japanese commercial bank lending while Latin American countries obtain the lion's share of their commercial bank credit from U.S. banks, as shown in

Table 5. On the eve of the Thai crisis, 54% of Thai liabilities were to Japanese banks (Kaminsky and Reinhart 2000).

Furthermore, there are studies of common lender effect, which describes how contagion can occur across several emerging markets that are exposed to a common group of investors or lenders, as a channel of contagion on financial crises. Van Rijckeghem and Weder (2001) and Kaminsky and Reinhart (2000) present empirical evidence in support of the view that spillovers through common lenders or financial linkages were important channels of contagion for the Mexican, Thai and Russian currency crises.

Finally, a number of literatures attribute the rapid pulling out of funds during crises as a major reason for perpetuating the financial crises. In the Asian crises, Japanese banks began to call loans from all the affected countries except Hong Kong. Likewise, U.S. banks pulled out from Latin America at the time of the debt crisis (Kaminsky and Reinhart, 2000). Corsetti et al. (1998) and Chang and Valesco (1998) provide an explanation that in the 1980s and 1990s, the Japanese financial institutions lent heavily outside Japan, especially to Asia, to seek higher returns for investment funds due to the stagnation of the Japanese economy. One of the reasons contributing to Asian crisis was the fact that the Japanese financial institutions called the funds back to rebalance portfolios because of the new capital adequacy requirement in 1997.

4.10.11 Summary

The economic characteristics of big-push are common observable economic phenomena in the emerging economies. High GDP growth is one of the key features due to the progressive "synchronization" of industrialization across sectors. These economic characteristics display dynamic behaviours, which are contingent on the ratio of wage premium on production and the industrialization state of an economy. Drawing parallels from the historical data of the emerging economies not only provides preliminary evidences, it provides justification for future research in taking up the challenge of calibrating and validating this model.

One of the key reasons why emerging economies are more susceptible to financial crises is because emerging economies are in the middle of industrialization states where disequilibrium, in term of fragility, is at its peak. While they are enjoying high growth in production and consumption, the emerging economies have to confront the economic fragility induced by the disequilibrium factors, especially the debts. On the other hand, the developed economies are less susceptible to financial crises because they are near to the high equilibrium, where the fragility of big-push is at its minimum.

5. The Implications

This model provides a simple economic framework, within which economic relationships can be readily derived, for examples, the economic relationships between change in unemployment and output growth (the Okun's Law) and between income inequality and output growth (the Kuznets Curve). Within this simple economic structure, all economic relationships are dynamic and contingent on the state of the economy, which is determined by the ratio of wage premium on productivity and the industrialization state.

In Section 5.1, the similarity of the Japanese GNP growth curve and the S-shaped output growth curve of this model offers a plausible conclusion that the Japanese economy has reached its high equilibrium in 1990s, way after Meiji government made a big-push into industrialization during the late 1800, to explain the stagnation of the Japanese economy in 1990s. In addition, this model offers plausible explanations to the empirical deviations of the Okun's Law or the Kuznets Curves as identified in the recent literature, in Section 5.2 and 5.3 respectively.

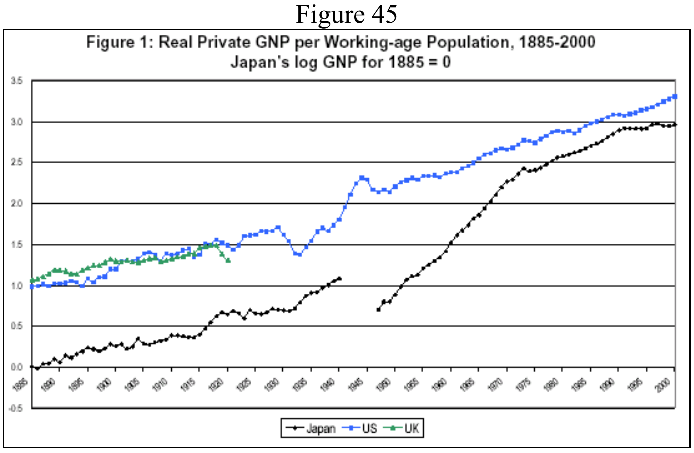
5.1 The Stagnation of Japanese Economy

The GNP plot of Japan from 1885-2000 as shown in Figure 45 displays a familiar S-shaped growth curve, which is similar to the S-shaped curve of the aggregate output simulated by this model, as shown in Figure 13. Since firms are not homogenous in reality, the similarity in S-shaped curve may confirm the following two things:

i. The ratio of wage premium to productivity, θ, must be roughly constant. This implies that the existence of a productivity-linked wage system, which is a common policy practiced by both company and government.
ii. The economic development progresses according to this model.

The Meiji government built Japan's modern infrastructure and actively introduced foreign technology in a variety of industrial sectors and in agriculture (Ito, 1992). Figure 45 shows slow but steady growth of the Japanese Economy from the Meiji period to World War II. The discontinuity of the GNP line shows the interruption of World War II when there was a sharp drop in productive capacity. Between 1950 and 1973, the Japanese economy grew at a remarkable growth rate, an average rate of ten percent a year (Ito, 1992). Then, the Japanese economy started to slow down and eventually became stagnant during 1990s.

Figure 45



Source: (See Hayashi and Prescott, 2003)

Several hypotheses have emerged in the literature to explain the stagnation of the Japanese economy in the 1990s. According to Krugman (1998), Japan was in a "liquidity trap"[18] such that the monetary policy was impotent to stimulate demand and raise spending since the Japanese interest rates were already near to zero. Dismissing the liquidity trap hypothesis, Hutchinson (2000) supports the credit crunch hypothesis which is an alternative explanation for the ineffectiveness of monetary policy to stimulate the Japanese economy. This explanation focuses on the contraction of the supply of bank credit caused by massive nonperforming loans accumulating in the financial system.

Bernanke and Lown (1991), Montonishi and Yoshikawa (1999) and Woo (1999) attributed the stagnation to a credit crunch. Kwon (1998) and Bayoumi (1999) concluded that fluctuations in asset prices affected output through bank lending. Ogawa and Suzuki (1998) found evidence from panel data on large Japanese firms that the price of land as collateral affected investment demands. Sasaki (2000) states that lending by "city" banks (large Japanese banks) was constrained by the BIS capital-ratio requirement. Ogawa and Kitasaka (1998) assert that the decline in asset prices shifted both the demand and supply curves bank loans, which resulted in a

[18] Keynes (1936) formulated the liquidity trap hypothesis, which suggests that at low levels of the rate of interest the demand for money could become highly, or even perfectly, elastic with respect to the interest rate. As a result, the monetary policy is impotent because any increase in the money supply will be hoarded.

fall in investment without a noticeable change in lending rates. Lastly, Hayashi and Prescott (2002) attribute the stagnation to a low productivity growth rate.

In contrast to those partial models, this model provides a more cogent and complete explanation for the stagnation of the Japanese economy in 1990s. The Japanese economy has apparently attained the high equilibrium. To achieve an even higher equilibrium, the Japanese economy needs to go through another big-push.[19] Alternatively, Japan can grow its economy through natural growth such as population growth or some other ways such as introduction of new products.

5.2 The Okun's Law

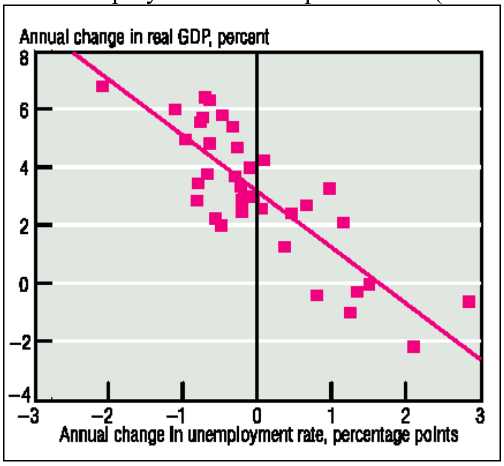
The relationship between unemployment rate and GDP growth is often formally summarized by the statistical relationship known as 'Okun's Law'. As developed by the late economist Arthur Okun (1962), the law relates decreases in the unemployment rate to increases in output growth. The Okun coefficient on unemployment is the coefficient of the regression (β) where the GNP growth rate is regressed on the change in unemployment rate, as shown in the regression equation: $\%\Delta Y = a - \beta\Delta U$. The negative correlation between changes in the unemployment rate and changes in GDP growth is viewed as one of the most consistent relationship in macroeconomics. The Okun's law is an important concept in macroeconomics both theoretically and empirically. Theoretically, Okun's law is the link between the aggregate supply curve and the Phillips curve. Empirically, the Okun coefficient is a useful 'rule of thumb' in forecasting and policy making as the federal government of U.S. used the change in employment rate to forecast the GDP growth (Harris and Silverstone, 2001).

In his original research based on the U.S. data, Okun (1962) found that a one-percentage point decline in the unemployment rate was, on average, associated with additional output growth of about two-percentage points. The basic economic theory behind the Okun's Law is that changes in the unemployment rate influence other factors that affect output growth, although the output of an economy does not depend directly on the unemployment rate. Altig et al. (1997) plotted the current version of Okun's Law as shown in Figure 46. The line indicates that the percentage change in output is roughly 3.2 minus two times the change in the unemployment rate,

[19] Perhaps, there is a long-term upper limit to resources consumption and utilization, which is the environmental sustainable equilibrium on the Earth.

($\%\Delta Y = 3.2 - 2\Delta U$). The intercept value of 3.2 percent is interpreted as "potential GDP growth" or "natural" (long-run) growth rate of the economy in the Okun's Law formulation.

Figure 46 Unemployment and Output Growth (1960-1996)



Source: U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Department of Labour, Bureau of Labour Statistics (See Altig et al., 1997)

Figure 47 – Okun's Law

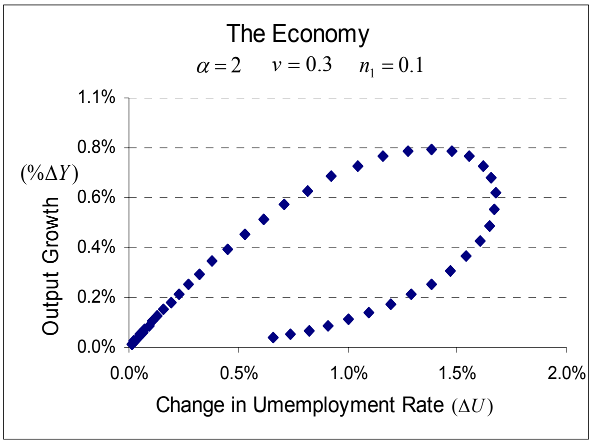


Figure 48 – Okun's Law

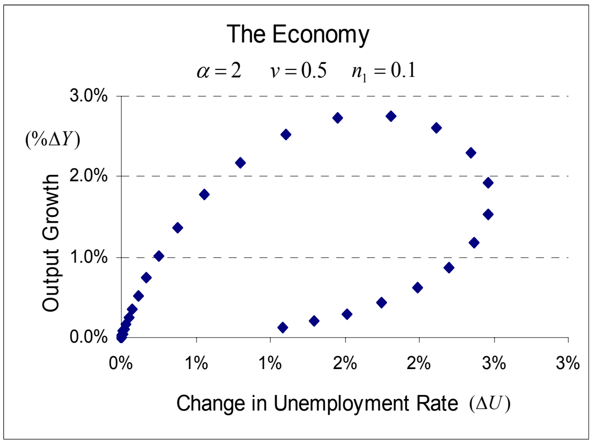


Figure 49 – Okun's Law

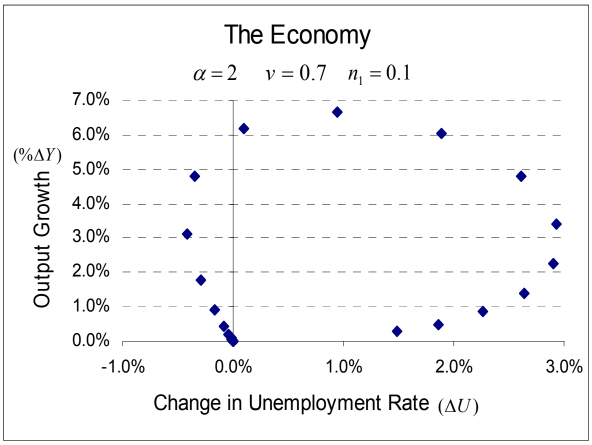
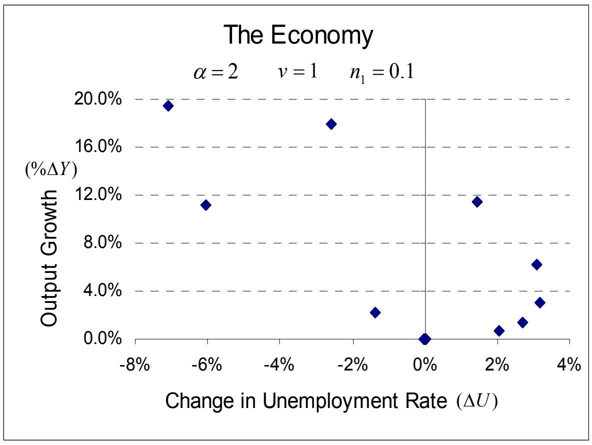


Figure 50 – Okun's Law



Based on this model, Figure 47 to Figure 50 show the plots of output growth against the change in unemployment rate for various wage premiums. The plots, which display circular loops, demonstrate that the relationship between output growth and the change in unemployment rate is in general positive but can be negative depending on the industrialization state. The plots seem to contradict a general view of the Okun's Law. However, by focusing around the equilibrium state (near the origin where $n = 1$) in Figure 49 or Figure 50, a familiar version of Okun's Law can be identified.

Figure 51

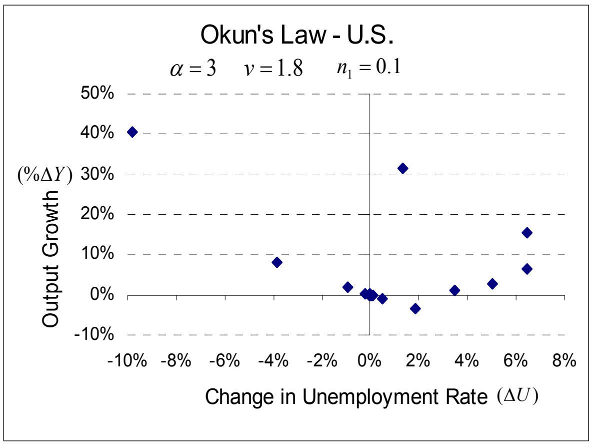
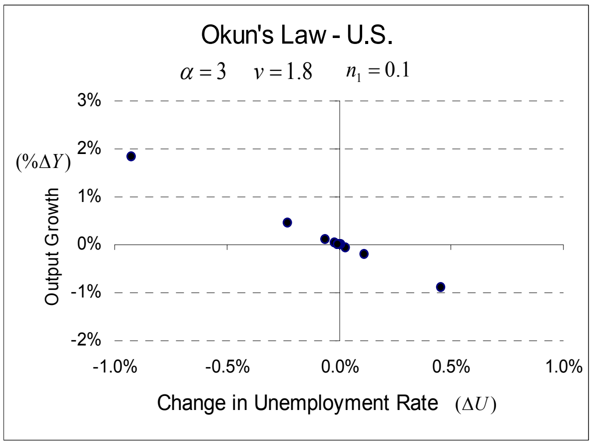


Figure 52



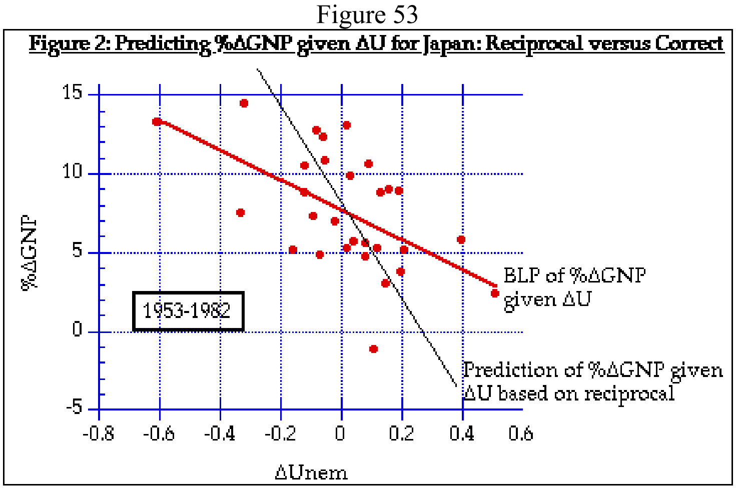
Assuming that U.S. economy has attained full industrialization status and stays around the equilibrium from 1960 to 1996, Figure 51 shows the simulated Okun's Law for the U.S. economy using this model with $\alpha = 3$ and $v = 1.8$. Focusing on data around the full industrialization or equilibrium state (near the origin), Figure 52 illustrates the simulated Okun's Law for the the U.S. economy, which has Okun coefficient on unemployment of two but the intercept is zero. This means that the natural growth rate of this model is zero, which can reasonably be interpreted as output growth not due to big-push process but some other ways of growth, such as population growth.

Okun's Law has been examined by a number of economists, including Smith (1975), Gordon (1984), Prachowny (1993) and Weber (1995) for U.S.; and Knoester (1986), Kaufman (1988), Hamada and Kurosaka (1984) for Japan and other OECD countries. Although the results generally support the empirical validity of the relationship in the sense of finding a significantly negative coefficient on cyclical output, the magnitude of the coefficient is highly sensitive due to the three major weaknesses in the Okun's Law: (1) the lack of dynamics within the joint bivariate process, (2) the statistical properties of the data, and (3) the non-stability of the unemployment/economy activity relationship (Candelon and Hecq, 1998).

Cuaresma (2003) concluded that changes in output can cause asymmetric changes in the unemployment rate; and Harris and Silverstone (2001) found that failure to take account of asymmetries would see a rejection of the hypothesis. There seems to be a consensus view that the relationship changed in the aftermath of the two oil shocks of 1973 and 1979 (Kaufman, 1988, pp. 187). As stated in Altig et al. (1997) and even in economic textbook by Blanchard (1999, pp. 170), the stability of the Okun coefficient has decreased or shifted over time.

Significant cross-country differences have been found, with larger coefficients on cyclical output obtained for the U.S. and Canada than for Europe and Japan (Kaufman, 1988; Moosa, 1997). Similarly, Sogner and Stiassny (2000) concluded that the reaction of the unemployment to changes in GDP differs substantially between the countries after estimating Okun's Law for 15 OECD countries.

Figure 53



Source: Figure 2, Barreto and Howland (1993)

The measure of Japan's Okun coefficient is quite controversial. Hamada and Kurosaka (1984), Mairesse (1984), Haraf (1984), Kaufman (1988) and Tachibanaki and Sakurai (1991) have all found extremely large Okun coefficients on unemployment for the Japanese economy. Barreto and Howland (1993) pointed out the problem of severely overestimating the Japan's Okun coefficient on unemployment using the reciprocal of the coefficient from the wrong regression (regression of change of unemployment rate on GDP growth). They concurred, however, that the Okun coefficient for the Japanese economy is still undoubtedly larger than that for the U.S.

economy. Figure 53 shows the Okun's Law for Japanese economy from 1953 to 1982 using the two different regression approaches.

As shown in Figure 45, the Japanese economy was on its way to high equilibrium from 1953 to 1982. Using this model with $\alpha = 3$ and $v = 1.48$, Figure 54 shows the simulated Okun's Law for the Japanese economy. Focusing on industrialization states near the equilibrium, Figure 55 illustrates a simulated Okun's Law for Japanese economy, which has an Okun coefficient on unemployment of about nine.

Figure 54 – Okun's Law (Japan)

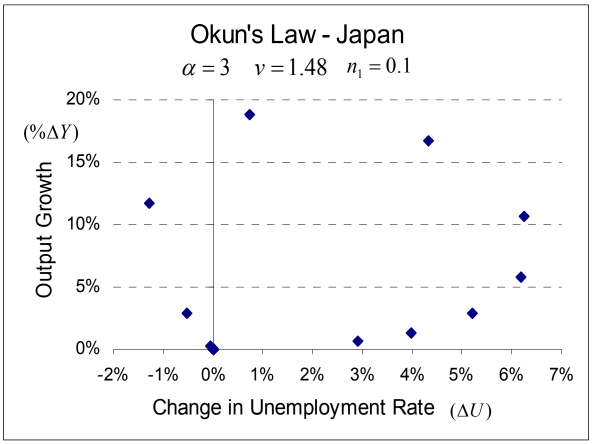
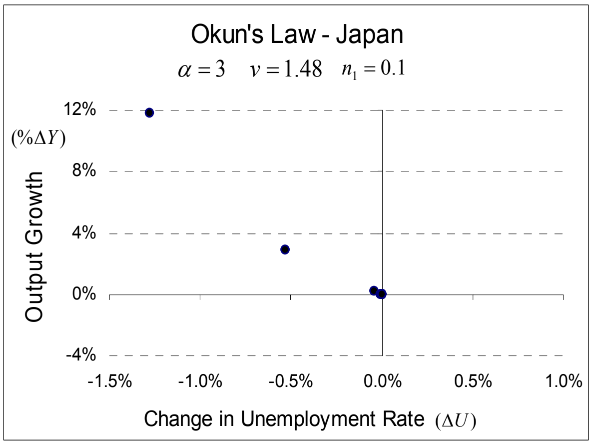


Figure 55– Okun's Law (Japan)



Zou and Hu (2003) pointed out that there is a significant deviation from the Okun's Law for the Chinese economy. In view of limited research on the Okun's Law for emerging economies, the Okun's Law may only prevail when an economy is at equilibrium. On the other hand, this model may provide a more cogent and comprehensive economic model for understanding the relationship between output growth and unemployment rate. Combining the three equations, Equation (5a), (22a) and (26) provide a unique and nonlinear relationship between change in unemployment rate and output growth, which depends only on three variables: industrialization state, wage premium and productivity. In summary, this model proposes a dynamic non-linear "loop" economic relationship, which depends on the ratio of wage premium on productivity and the industrialization state of an economy, between output growth and change in unemployment rate.[20]

[20] The "loop" is referred to the shape of the relationship as shown in Figure 47 to Figure 50.

5.3 The Kuznets Curve

The Kuznets Curve is accepted as a strong empirical regularity (Ahluwalia, 1976a & 1976b; Barro, 2000) and the Kuznets relation is statistically significant (Papanek and Kyn, 1986). As discussed in Section 4.9.3, this model exhibits inverted-U curve which are similar to the Kuznets Curve.

Figure 56 to Figure 59 show the plots of Gini Coefficient against output growth for different wage premiums. Although the relationship between inequality and growth is generally positive, Figure 59 shows that the relationship can behave like a circular loop, where a positive and a negative relationship between growth and inequality coexist. High growth is associated with both high and low inequality depending on the low or high industrialization state respectively.

Figure 56 – Equation (35) vs $\%\Delta Y_t$

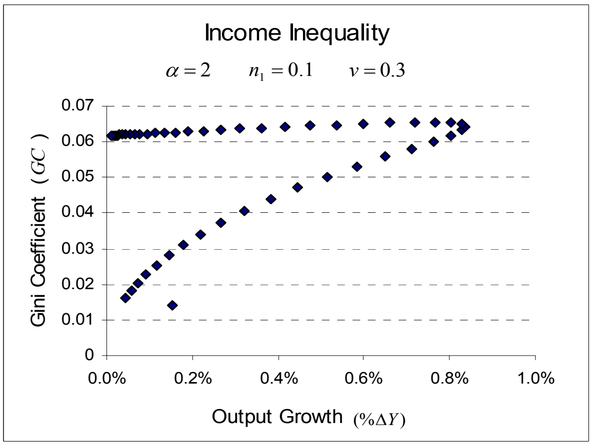


Figure 57 - Equation & (35) vs $\%\Delta Y_t$

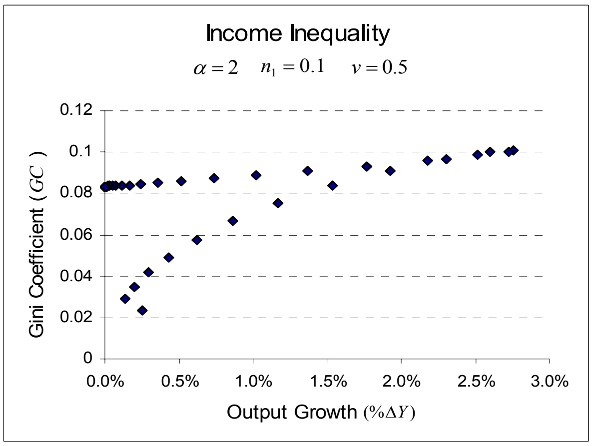


Figure 58 - Equation (35) vs $\%\Delta Y_t$

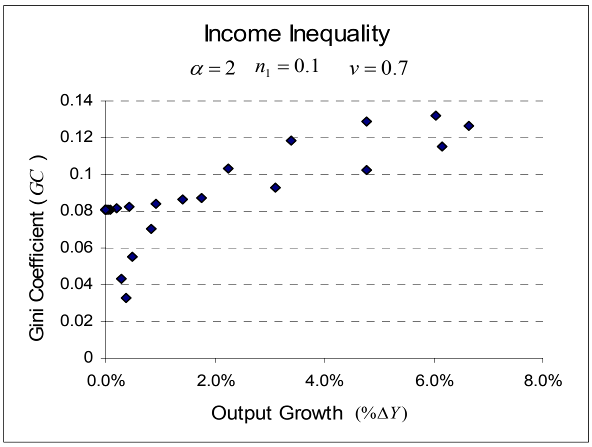
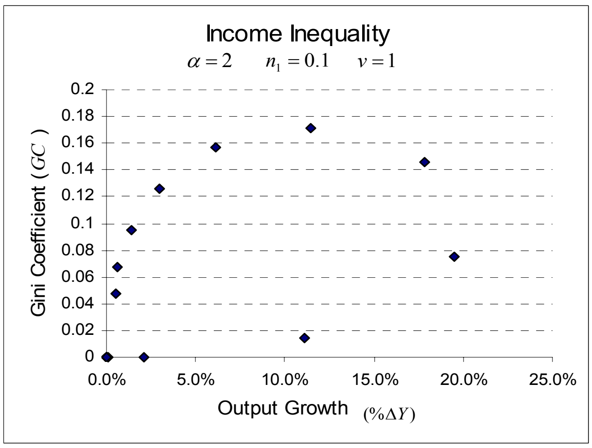


Figure 59 - Equation (35) vs $\%\Delta Y_t$



In the Kuznets relation, the income inequality and output growth follows a positive linear relationship, assuming the growth path progresses linearly. This model shows that the relationship between inequality and growth may be complex and varies with the ratio of wage premium on productivity and the industrialization state of an economy, as shown in Figure 56 to Figure 59. The key reason is that the dynamic path of big-push is an S-shaped curve rather than a positive linear line.

Although the Kuznets Curve has been one of the stylised facts of the study of income distribution for nearly four decades, some recent works have refuted it. Deininger and Squire (1996) conclude: "there appears to be little systematic relationship between growth and changes in aggregate inequality" and Deininger and Squire (1998) conclude: "our data provide little support for an inverted-U relationship between levels of income and inequality". Anad and Kanbur (1993) claim the relationship has weakened over time. Some empirical works show that inequality is in fact negatively correlated with growth (Clarke, 1992; Ravallion and Chen 1997). Li, Squire and Zou (1998) argue that the Kuznets Curve works better for a cross section of countries at a point in time than for the evolution of inequality over time within countries. More recently models that feature a Kuznets Curve are models which involve a shift from a financially unsophisticated financial environment to a modern financial system (Greenwood and Jovanovic, 1990) or model a shift from an old technology to a more advanced technology (Aghion and Howitt, 1997; Galor and Tsiddon, 1997; Helpman, 1997).

Perhaps, this model can provide a more cogent and comprehensive theory for understanding the relationship between income inequality and output growth beyond the Kuznets relation. This model proposes a dynamic non-linear "loop" economic relationship, which is contingent on the ratio of wage premium on productivity and the industrialization state of an economy, between output growth and income inequality.

6. Conclusion

In this paper, a new growth model driven by two key parameters: the wage premium and the productivity, is constructed based on the theory of big-push. This model is a multi-equilibrium model and has low and high steady states, corresponding to the no-industrialization and full-industrialization state. Capturing the true essence of big-push, this model involves a kick-start in order to initiate a big-push process. Beside the typical S-shaped dynamic path, this model can exhibits chaotic behaviours if the ratio of wage premium on productivity is higher than a certain value.

Within the simple economic structure of this model, the economic characteristics of big-push display dynamic behaviours which are common observable economic phenomena in the emerging economies. One of the key economic features of big-push is a high economic growth due to the progressive "synchronization" of industrialization across sectors. Drawing parallels from the historical data not only provides preliminary evidences, it provides justification and motivation for future research to take up the challenge of calibrating and validating of this model.

In this model, the characteristics of disequilibrium growth introduce fragility into the emerging economies. One of the key reasons why emerging economies are more susceptible to financial crises is because emerging economies are in the middle of industrialization states where disequilibrium, in term of fragility, is at its peak. Leow (2004) extends this model to simulate the Sudden-stop phenomenon of financial crisis as advocated by Calvo (1998).

After the Meiji government made a big-push into industrialization in late 1800, the fact that the Japanese economy has already attained its high equilibrium offers a simple yet plausible explanation to the stagnation of the Japanese economy in the 1900s. In providing plausible theoretical reasons for the empirical deviations of Okun's Law and Kuznets Curve as identified in the recent literature, this model proposes a hypothesis that there is a dynamic non-linear "loop" economic relationship, which is contingent on the state of a economy determined by the ratio of wage premium on productivity and the industrialization state, between output growth and income inequality and between output growth and change in unemployment rate. The validation of these "loop" relationships will be another challenge for future research.

In general, this model may have a significant implication for economic theories that economic relationships may not be static but dynamic and contingent on the state of an economy, which is determined by the ratio of wage premium on productivity and the industrialization state.

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Table of Symbols

Subscripts

$Y_{Ci,t}$	The output of a cottage-firm at time t
$Y_{C,t}$	The aggregate output of cottage-firms at time t
$Y_{Ti,t}$	The output of a technology-firm at time t
$Y_{T,t}$	The aggregate output of technology-firms at time t
Y_t	The aggregate output of the group-economy at time t

Parameters

α	Production productivity
β	Okun coefficient
γ	Proportionate gain in productivity $(\alpha - 1)/\alpha$
ε	Employment rate
v	Wage premium
θ	Ratio of wage premium on productivity (v/α)
τ	The time at which the economy attains high equilibrium ($n = 1$ at $t = \tau$)
Π	Operating profit
$\Im$	Present value of operating profits (financing capability of a technology-firm)
i, j	Count
n	Industrialization state (Low equilibrium state: $n = 0$, High equilibrium state: $n = 1$)
r	Interest rate
s, t	Time
$t1$	Time at which a technology-firm takes up a bank loan to invest in IRS technology.
$t2$	Time at which a technology-firm clears its debt.
w	Wage rate
w_U	Employment benefit (dole)
B	Debt
C	Consumption
∇C	Extra consumption

D	Spillover demand ($Q-Y$)
E	Employment
F	Period debt repayment
G	Surplus inventory
L	Labour endowment (numeraire)
N	Number of complementary firms
Q	Demand
S	Period Savings
U	Unemployment rate
ΔU	Change in unemployment rate
V	Average of the product of employment rate and wage premium
W	Labour cost
∇W	Extra Disposable Income
Y	Output
∇Y	Extra output ($Y_T - Y_C$)
Z	Investment failure function
CI	Capital inflow
GC	Gini coefficient
$\%\Delta C$	Consumption growth rate
$\%\Delta W$	Income growth rate
$\%\Delta Y$	Output growth rate