Has the Globalisation really generated more competition in OECD economies

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Globalization, Great Moderation and the Rise of the Global Mark-up

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Abstract

Since the 1970's, firms struture have changed to fit the Globalization of the Market. Some firms have suffered from increased competition, whereas others, generally big ones in the Business to Consumer sector, have enjoyed a decrease in competition. The market power of firms can affect the monetary policy trade-off between output volatility and price volatility. This trade-off is generally studied with the New Keynesian Philips Curve equation, which can be obtained by assuming Calvo or Rotemberg price setting assumptions. Both can involved a market power parameter. But the Calvo model fails to predict the increase of price volatility on markets, like manufactured goods, where competition has definitively increased. By using the Rotemberg assumption and modelling firms according to the Theory of firm Literature, the model generates the Great Moderation, only if we assume a global rise of the markup in OECD economies since the beginning of the 1980's. It also generates two other stylized facts since the beginning of the 1980's: a rise in wage variability and in labor variability relative to output variability. This simple model replicates a value of the NKPC quite close from empirical estimations since the 1990's. The model steady state with a higher value of mark-up since 1980 supports the fact that inequalities are higher since the Great Moderation. To finish, it gives a simple explanation for the barely growth of median wage compare to the growth of global productivity.

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1 Introduction

Theory of Firm Literature gives very interesting information about the commun mutation of the structure of big companies in the OECD economies. During the late 1970's and the 1980's their governance changed a lot. Until the late 1970's, the "'Ford Shape"' was the most spread structure of big firms: they were very vertically integrated and the strategy oriented to quantity and price priority. But consumers began to ask for more quality and differentiation. In addition competition arised because of the steady product market deregulation.

[22] described how the former vertical integrated companies externalized all the activities which not belonged to their core activites in order to keep the most profitable ones. The horizontal and vertical networks of firms was imposed in all activities and sectors were the value added to output was high, [1]. The horizontal network is very long lasting and, by the way, not very interesting for our purpose. The most famous model of vertical network is called the "'network firm"': a leader firm runs a range of smaller ones. Generally, the smaller firms are juridically and financially independant. They work with the leader firm to gather their special abilities by contractualizing their relationship, [12],[10], [13]. This new organisation fits both flexibility and innovation constraints that the global market laid down. Almost every sectors of OECD economies were affected by this mutation during the 1980's. Running a "'network firm"' became more and more easier with the improvement of ICT,[10]. The leader firm runs all the supply chain, by organising logistics between smaller firms. The leader firm is usually in charge of the R&D activity, the final sail activity, the marketing activity, the financial activity (like mergers) and quality control activities for the whole "'network firm"'. Therefore high-skilled labor is generally employed in the leader firm. The average skill of employees in smaller firms is lower.

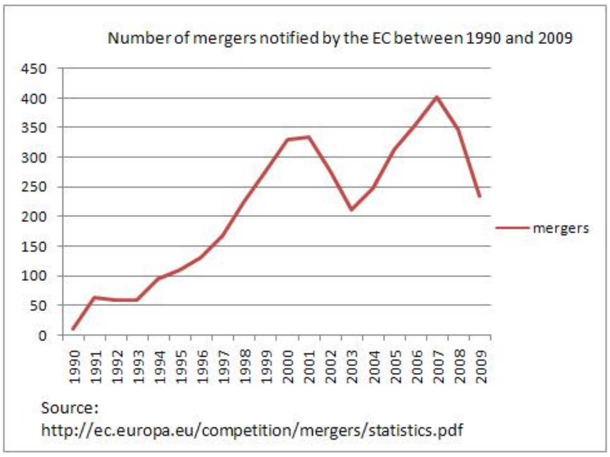
To sum up, the leader firm aims at improving the productivity of the whole "'network firm"' to satisfy the final consumer as much as possible in the context of market globalization.

In the Macroeconomics Literature, the globalization of markets is associated with more competition among firms, which has improved the welfare of consumers. The pure rents, i.e the monopoly power which enables firms to determinate price above the marginal cost, should have decreased during this period,[24]. However they are unobservable. Some economists have analysed the evolution of different variables which likely affect the pure rents. In [5],the product market deregulation should be the main cause of the fall in pure rents. First of all, the index of barriers to entrepreneurship (a composite of product market regulation) has clearly decreased in all important OECD economies between 1975 and 1998. The deregulation began in the mid 1980's in Anglo-Saxon countries. Secondly the level of foreign trade has increased which should generate a greater competition. Thirdly the degree of state ownership of firms in the business sector has steadily declined. As a consequence, the authors assessed for a decrease of pure rents in OECD economies since the late 1970's.

Nevertheless this hypothesis is not always suitable for firms like leader firms,[27]. The globalisation creates greater scale. Multinationals can absorb greater fixed cost, like marketing and R&D expenditure, to produce differentiated and more technology intensive products. Therefore, a national monopoly (oligopoly) has incentives to become a global monopoly (oligopoly), as it is illustrated in the aeronautic sector by Boeing and Airbus. A lot of high technology sectors are indeed dominated by a large monopoly or oligopoly (Pharmacy, software, chain retailling...). [27] argued that globalisation could create less contestable market. Because of network externality, a multinational first entrant can impose its technology to all the market, which create a private monopoly that could be reinforced by TRIPS, the WTO's intellectual property rights agreements. [27] finally pinpointed the incentives for multinational company to rise private barriers and to shape negative market discrimination.

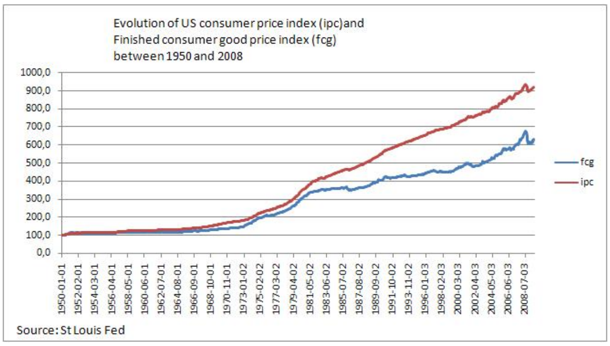
Moreover two other variables advocate a rise in the rent of leader firm during this last 3 decades. On the one hand, the number of european and american mergers have largelly increased. Figure 1 shows the evolution of number of the largest european mergers notified at the European Commission. In the United states, the numbers of mergers is at least ten times bigger, [27].

Figure 1: Numbers of Largest European Mergers between 1990 and 2009



On the other hand, the gap between the american consumer price index and the american finished consumer good price index have significantly increased since the 1980's, which is presented Figure 2. Along the supply chain, the leader firm are generally located at the end, between producers and final consumers, it seems that they have enjoyed an increased mark-up. But this is not a proof, just a clue for assessing a bigger rent. Indeed, the evolution of the consumer price index is biaised by the development of services during the period.

Figure 2: Evolution of american cpi and american fcgpi



A puzzle arises when we look at the volatility evolution of producer price index (B2B price) and consumer price (B2C price) index. After the mid 1980's the volatility of the consumer price index has decreased, whereas the volatility of different price index from the industrial BtoB sector has suffered from an increase. The shows this puzzle for Australia, Canada and United States. A lack of data before the 1980's makes the comparison impossible for others OECD economies. According to the data and the methodology used to estimate the evolution of the price volatility, very different values can be obtained. Here I used the growth of the different price index to obtian inflation index. Then I compute the moving average of growth over a period of four years and the gap between the former and the latter. I finally compute the standard deviation of the gap to find the values in the table.

Australia	*1969-1987*	*1988-2008*
Manufactured Producer price Index	0,00760	0,01184
Consumer Price index	0,00830	0,00534
Canada	*1956-1984*	*1985-2007*
Manufactured Producer price Index	0,00839	0,00969
Consumer Price index	0,00524	0,00467
United States	*1954-1984*	*1984-2005*
Producer Price Index: Intermediate Materials	0,00564	0,00575
Producer Price Index: Industrial Commodities	0,00457	0,00836
Producer Price Index: Finished Consumer Goods	0,00548	0,00584
Consumer Price index	0,00298	0,00251

Sources: St Louis Fed and OECD

Using monthly data from St Louis Fed, between 1950 and 2009, we see that the volatility of the three producer price index have increased. The volatility of the american intermediate materials price index was about 0.00564 between 1954 and 1984, whereas it increased to 0.00575 between 1984 and 2005. The volatility of industrial producer price index was 0.00457 and became 0.00386 during the same period. The volatility of finished consumer good price index was 0.00548 during the first period and rised to 0.00584 during the second one. Although, the volatility of consumer price index decreased from 0.00298 to 0.00251. With canadian quaterly data from the OECD database between 1956 and 2009, we show that the volatility of the canadian manufactured product price index has doubled, from 0.00839 to 0.00969 , to between the period 1958-1984 and the period 1985-2007. The Canadian consumer price index grew just a little bit from 0.00524 to 0.00467 during the same period, which can be considered like a stagnancy of this volatility. Using Australian quaterly data from the OECD database between 1968 and 2009, we see that the volatility of the australian manufactured product price index has largely increased, from 0.00760 to 0.01184, between the period 1968-1984 and the period 1985-2008. Althought, the consumer price index only grew from 0.00830 to 0.00584 during the same periods. Consumer price index are less volatile than producer price index in the three economies (except in Australia during the first period but it changes with the lenght)
Whatever the right magnitude, the decrease of the consumer price index volatility remains a large concensus among economists as well as the decrease of output volatility in all major

OECD economies,[6], [28]and [19]. This stylized fact ,usually called the "'Great Moderation"', is commun to all major OECD economies but with different timings and magnitudes,[28]:

Figure 3: The beginning of Great Moderation by country

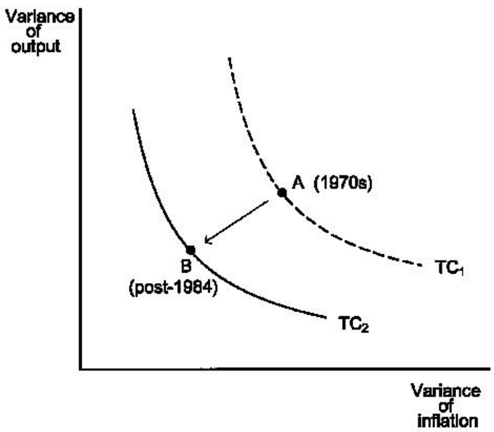
The Great Moderation: magnitude and dates of GDP volatility reduction

	Ratio of low to high volatility	Date of switch to low volatility
Australia	45,8	1984 Q3
Canada	58	1988Q1
France	54,2	1976Q3
Germany	48,3	1971Q3
Italy	50,8	1980Q2
Japan	62,9	1975Q2
United Kingdom	51,5	1982Q2
United States	50,8	1984Q4

Source: "What Caused the Great Moderation: Somme Cross-Country Evidence" P.Summers (2005)

The New Keynesian Philips Curve (NKPC) framework, using consumer price index, easily illustrates the Great Moderation as a decreasing trade-off between output volatitlity and inflation volatility for the Monetary Authority, [6].

Figure 4: Evolution of the New Keynesian Philips during the last three decades



The NKPC, using consumer price index, moved from the right to the left. Thus we can assert that the NKPC using producer price index remained the same or rised its locus: for a smaller output volatility, the producer price index is more volatile.

Many theories have emerged to explain the Great Moderation. The "Good Luck Theory" about the smaller shocks in OECD economies convices less and less economists, like [9] or [14] whose empirical studies led to support explanations about structural changes. We have to notice that the latter article highlights an increase in the volatitlity of hours worked relative to output during the Great Moderation. Most of the authors claim for a more trusted monetary policy in the United States. Unfortunately this cause is not sufficient for explaining the English Great

Moderation, [2].[8] claims for a better stock management thanks to a better use of technology and Just In Time. A more flexible labor market would have generate the great moderation according to [20], [19]. The less energy dependancy would explain why the rise in oil price since 2002 didn't create stagflation, [21], [23]. To finish, better credit accessibility could be one of the causes, [4].
Unfortunately none of these theories is able to explain the puzzle of the increased volatility of producer price index. The hypothesis of the increased global rent can.

In the next section we will create a NKPC model which account for market power of leader firms and smaller firms according to the Theory of firms Literature. In the third section we will replicate the Great Moderation with many other stylised facts only if we assume that the global rent has increased. We finaly discuss the simulations and conclude in the last section.

2 The Model

2.1 The failure of the Calvo model

In this paper we will assume as equivalent the pure rent and the mark-up, which determine the market structure: an increase (decrease) of the mark-up means an fall (rise) in competition. In [18] the effect of market structure on the slope of the New keynesian Philips Curve is studied. Since [26], it is well known that the reduced-forms obtained by the Rotemberg,[25] and the Calvo,[7], price setting assumptions are quite the same. The NKPC reduced-form obtained from the Calvo assumption is affected by the mark-up, only if we assume a environment of "'strategic complementary"', [29]. For the latter NKPC reduced-form, an increased competition among firms implies a decrease in price variability, whereas for the former, it implies an increase. Assuming an increase in global competition and using the decreasing consumer price index volatility, [18] concludes that the Calvo model was more suitable than the Rotemberg model.
However, services are an important part of the consumption basket but they are not very tradable, unlike manufactured goods. Thus, the Globalization has defenitely increased competition among manufactured product markets, as Chinese impressive development corroborates. But the variability of producer price index, notably about manufactured products price index, increased a lot during the period of the Great Moderation in Australia, in Canada and in the

United States. [18] conclusion is no more suitable, the Rotemberg model is. That's why we will use it in the following NK model.

2.2 Households

We assume a continuum of infinitely-lived and identical households. The representative household maximises a discounted sum of expected utilities:

$$\Omega_t(j) = \sum_{s=t}^{\infty} \beta^{s-t} E_t \left\{ \frac{1}{1-\sigma} C_s^{1-\sigma}(j) - \frac{1}{1+\psi} L_s^{1+\psi}(j) \right\}$$

where $j \in [0;1]$, β is the subjective discount factor, $C_t(j) = \left[\int_0^1 C_t(j,i)^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}}$, the Dixit-Stiglitz constant elasticity-of-substitution-compsumtion index, $C_t(j,i)$ represents consumption by j of the ith good, $L_t(j)$ is the supply of labour. $\sigma > 0$, is the intertemporal elasticity of substitution of aggregate expenditure. ψ is the desutility of labour, or the inverse of Frish elasticity.

The households are limited by the standard budjet contraint:

$$P_t C_t(j) + \frac{B_{t+1}(j)}{(1+r_t)} = W_t(j) L_t(j) + L_{hs}(j) + B_t(j) + \Pi_t^u(j) + \Pi_t^d(j) + T_t(j)$$

$P_t = \left[\int_0^1 P_t(i)^{1-\theta} di\right]^{\frac{1}{1-\theta}}$ is the price consumer index, $B_t(j)$ is a bond which enable j to save between to periods. $W_t(j)$ is the nominal wage of j. $L_{hs}(j)$ is a constant earning from the downstream firms to j. $\Pi_t^u(j)$ denotes the share of profit given to j from the total profit of the upstream firms, and Π_t^d is the same for the downstream firms. $T_t(j)$ is the cost of changing price for all the companies which is paid by j. The utility maximising conditions are

$$L_t^{\psi}(j) = \frac{W_t(j)}{P_t} C_t^{-\sigma}(j)$$

$$E_t \left[\beta \left(\frac{C_{t+1}(j)}{C_t(j)} \right)^{-\sigma} (1+r_t) \right] = 1$$

2.3 Firms

According to the Theory of firms Litterature, we try to replicate a simple "‘network firm"’ model with the smaller firms and the leader firms. Now the smaller firms will be represented by the representative upstream firm and the leader firm by the representative downstream firm.

2.4 The upstream sector

Each firm produces a differentiated intermediate good indexed by h. They are uniformly distributed on the interval $[0;1]$. They operate in a monopolistically competitive market with the same production function.

$$Y_t^u\left(h\right) = A_t L_t^{\alpha}\left(h\right)$$

Each firm faces a demand curve from the downstream sector:

$$Y_t^u\left(h\right) = \int_0^1 \left(\frac{P_t^u(h)}{P_t^u}\right)^{-\theta_u} Y_t^d\left(i,h\right) di$$

with $Y_t^d\left(i,h\right)$ the demand from the downstream firm i to the upstream firms h. $Y_t^d\left(i\right) = \left[\int_0^1 Y_t^u\left(i,h\right)^{\frac{\theta^u-1}{\theta^u}} dh\right]^{\frac{\theta^u}{\theta^u-1}}$ the demand from the downstream firm i to all the differentiated upstream firms h, and $Y_t^u\left(h\right) = \int_1^0 Y_t^u\left(i,h\right) di$ the total output of the downstream firm h. $P_t^u\left(h\right)$ is the price of the upstream firm h and $P_t^d\left(i\right)$ the price of the downtream firm i. $0 < \alpha < 1$ is the elasticity of upstream output with respect to labour. θ^u is elasticity of demand for downstream firm i. We implicitly assume that the capital stock is firm specific and constant over time.

2.5 The downstream sector

Each upstream firm produces a differentiated final good indexed by i. They are uniformly distributed on the interval $[0;1]$. The number of downstream firm is equal to the number of upstream firm. Making the number of downstream firm smaller would have fitted a real fact, but it would have made the model more complex without improving the results. They operate in a monopolistically competitive market with the same production function.

$$Y_t(i) = A^d Y_t^d(i)$$

As presented above, the activity of the downstream firm consists in improving the output of the upstream sector by organising the whole organistion thanks to the development of marketing, logistics, financial and R&D services.

Each firm faces a demand curve from the final consumer:

$$Y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\theta} Y_t$$

with $Y_t = \left[\int_0^1 Y_t(i)^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}}$ for the aggregate demand. $P_t(i)$ is the price of the downstream firm i.

2.6 The Rotemberg model

Following [25], each firm of both sectors faces a quadratic cost of price adjustement, measured in terms of the final good. For uptstream firms, the cost adjustement is based on real price because the downstream firm cares about the real cost variability. Penalties to cover additionnal management costs of the whole "‘network firm"’can be paid from the upstream firms to the downstream firms.

$$\frac{c_u}{2}\left(\frac{\frac{P_t^u(h)}{P_t}}{\pi\frac{P_{t-1}^u}{P_{t-1}}(h)} - 1\right)^2 \frac{Y_t}{A^d}$$

For the downstream firms, the cost adjustement is based nominal price,

2.7 The Rotemberg model for the upstream firms

The representative upstream firm chooses its real price $\frac{P_t^u(h)}{P_t}$ at each period to maximise its profit. Information is not perfect. We assume that upstream firms cannot forsee the optimal $\frac{P_t^u(h)}{P_t}$. Indeed, in a small firm the financial and accounting departments are more or less developed and the downstream firms could whenever change price bargaining conditions by using their potential greater market power induced by the "‘network firm"’ model.

$$P_t^u(h) Max \Pi_t^u(h) = \frac{P_t^u(h)}{P_t} Y_t^u(h) - \frac{W_t(h)}{P_t} L_t(h) - \frac{c_u}{2} \left(\frac{\frac{P_t^u(h)}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} - 1 \right)^2 Y_t^u$$

which becomes:

$$P_t^u(h) Max \Pi_t^u(h) = \left(\frac{P_t^u(h)}{P_t} \right) \left(\frac{\frac{P_t^u(h)}{P_t}}{\frac{P_t^u}{P_t}} \right)^{-\theta_u} \frac{Y_t}{A^d} \int_0^1 \left(\frac{P_t^d(i)}{P_t} \right)^{-\theta} di -$$
$$\left[\left(\frac{\frac{P_t^u(h)}{P_t}}{\frac{P_t^u}{P_t}} \right)^{-\theta_u} \frac{Y_t}{A^d A_t} \int_0^1 \left(\frac{P_t^d(i)}{P_t} \right)^{-\theta} di \right]^{\frac{1}{\alpha}} \frac{W_t(h)}{P_t} - \frac{c_u}{2} \left(\frac{\frac{P_t^u(h)}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} - 1 \right)^2 \frac{Y_t}{A^d}$$

The first order condition is

$$(1-\theta^u) \frac{\left(\frac{P_t^{u*}(h)}{P_t} \right)^{-\theta_u}}{\left(\frac{P_t^u}{P_t} \right)^{1-\theta_u}} \frac{Y_t}{A^d} - \left(\frac{Y_t}{A^d A_t} \right)^{\frac{1}{\alpha}} \left(-\frac{\theta_u}{\alpha} \right) \frac{\left(\frac{P_t^{u*}(h)}{P_t} \right)^{-\frac{\theta_u}{\alpha}-1}}{\left(\frac{P_t^u}{P_t} \right)^{\frac{-\theta_u}{\alpha}}} \frac{W_t(h)}{P_t} -$$
$$c_u \left(\frac{\frac{P_t^u(h)}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} - 1 \right) \frac{Y_t}{A^d} \frac{1}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} = 0$$

If we log-linearise this equation at the symetric equilibrium:

$$p_t^u - p_{t-1}^u = \frac{\theta_u - 1}{c_u} \frac{1 - \alpha + \psi + \sigma\alpha}{\alpha} (y_t - y_t^n) + -p_{t-1}^u$$

with

$$\tilde{y}_t = y_t - y_t^n$$

$\tilde{y}_t$ denotes the global output gap betwenn the final output y_t and the natural output y_t^n. p_t^u is the loglinearized value of the real upstream price.

We will assume that the log-linearised inflation rate of upstream prices is

$$\pi_t^u = p_t^{u*} - p_{t-1}^{u*}$$

2.8 The Rotemberg model for the downstream firms

The core activities of the downstream firm is the conception, the coordination and the monitoring of the supply chain, [11]. There is no direct link between these three tasks and the quantity of output. We will then suppose that the cost of (high-skilled) labor in dowstream firms is constant. In addition, the downstream firms have developed their accounting and financial departements very well. We then consider that they can determine their next period optimal price. Given $\frac{P_t^u(h)}{P_t}$ a downstream firm chooses a sequence of $P_t^d(i)$ to maximize the expected sum of future discounted profits.

$$P_t^d(i) Max \Pi_t^d(i) = E_t\left[\sum_{s=t}^{\infty} R_{t+s}\left(\frac{P_{t+s}^d(i)}{P_{t+s}} Y_{t+s}(i) - \frac{P_{t+s}^u(i)}{P_{t+s}} Y_{t+s}^d(i) - \frac{c_d}{2}\left(\frac{P_{t+s}^d(i)}{\pi P_{t+s-1}^d(i)} - 1\right)^2 Y_{t+s} - L_{hs}(i)\right)\right]$$

where $R_{t+s} = \beta^s C_s^{-\sigma}$ is the stochastic discount factor. $P_t^d(i) = \left[\int_0^1 P_t^u(h)^{1-\theta_u} dh\right]^{\frac{1}{1-\theta_u}}$ is the price index of $Y_t^d(i)$ the intermediate consumption of i from all upstream firms. $L_{hs}(i)$ is the constant cost of high skilled labor employed by the downstream firm i whose value makes $\Pi_t^d(i) > 0$ since big firms have often given stock dividends to shareholders during the Great Moderation.

The profit can be written as:

$$P_t^d(i) Max \Pi_t^d(i) = E_t \sum_{s=t}^{\infty} R_{t+s}\left(\frac{P_{t+s}^d(i)}{P_{t+s}}\left(\frac{P_{t+s}^d(i)}{P_{t+s}}\right)^{-\theta} Y_{t+s}(i) - \frac{P_{t+s}^u(i)}{P_{t+s}}\left(\frac{P_{t+s}^d(i)}{P_{t+s}}\right)^{-\theta} \frac{Y_{t+s}(i)}{A^d} - \right.$$
$$\left.\frac{c_d}{2}\left(\frac{P_{t+s}^d(i)}{\pi P_{t+s-1}^d(i)} - 1\right)^2 Y_{t+s} - L_{hs}(i)\right)$$

The first order condition is:

$$R_t(1-\theta)\frac{P_t^{d*^{-\theta}}(i)}{P_t^{1-\theta}} Y_t + R_t \frac{Y_t}{A^d}\frac{P_t^u(i)}{P_t}\theta \frac{P_t^{d*^{-\theta-1}}(i)}{P_t^{-\theta}} - R_t c_d\left(\frac{P_t^{d*}(i)}{\pi P_{t-1}^d(i)} - 1\right) Y_t \frac{1}{\pi P_{t-1}^d(i)} +$$
$$E_t R_{t+1} c_d\left(\frac{P_{t+1}^d(i)}{\pi P_t^{d*}(i)} - 1\right) Y_{t+1}\frac{P_{t+1}^d(i)}{\pi P_t^{d*2}(i)} = 0$$

We can easily obtain the downstream price equation:

$$P_t = \frac{1}{\frac{\theta-1}{\theta} + \frac{c_d}{\theta}\left(\left(\frac{\pi_t}{\pi} - 1\right)\frac{\pi_t}{\pi} + \beta E_t \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\left(\frac{\pi_{t+1}}{\pi} - 1\right)\frac{\pi_{t+1}}{\pi}\frac{Y_{t+1}}{Y_t}\right)}\frac{P_t^u(i)}{A^d} = \mu_t \frac{P_t^u(i)}{A^d}$$

where μ_t is the mark-up over the marginal cost $\frac{P_t^u(i)}{A^d}$. There are two terms in the denominator of the mark-up. The first term, $\frac{\theta}{\theta-1}$ represents the standard mark-up and the second term the cost of adjustment price that it is takes in account.

$$\frac{c_d}{\theta}\left(\left(\frac{\pi_t}{\pi} - 1\right)\frac{\pi_t}{\pi} + \beta E_t \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\left(\frac{\pi_{t+1}}{\pi} - 1\right)\frac{\pi_{t+1}}{\pi}\frac{Y_{t+1}}{Y_t}\right)$$

represents the net cost associated with price adjusment. When there is no stickiness ($c = 0$), the mark-up is the same as the desired mark-up, $\frac{\theta}{\theta-1}$.

Log-linearise this last equation gives the NKPC of downstream firms:

$$\pi_t = \frac{\theta-1}{c_d}\frac{\theta_u-1}{c_u}\frac{1-\alpha+\psi+\sigma\alpha}{\alpha}\tilde{y}_t + \frac{\theta-1}{c_d}p^{u*}_{t-1} + E_t\beta\pi_{t+1}$$

2.9 Market structure and the Slope of NKPC

The steady state elasticities of demand for the representative downtream firm θ_u, and an upstream firm θ , capture the degree of substituability betwenn their own goods and those of their competitors. These elasticities are inversely related to the desired mark-up over cost that firms want to charge for their output. A higher substituability between goods implies a higher degree of competition among firms, and a lower desired mark-up (a reduction in firm's price power). A structral increase in competition among firms is interpreted in terms of a one off increase in the (steady state) elasticity.

Within a standard NKPC with Rotemberg price setting assumption, a higher competition among firms increases the slope of the Phillips curve and tends to magnify inflationnary pressures.Therefore, the market srtucture of the upstream and the downstream firms affect the variablility of consumer prices. Actually higher competition makes adjustment price relatively cheaper (the second term in denominator of μ_t). For a given magnitude of price adjustement costsc_d, a higher θ lowers the net cost associated with adjusting prices. The size of the optimal price adjustement falls with the increase of competition (as θ increase), which makes price adjustement relatively cheaper for a firm when facing quadratic adjustment cost. This effect promotes price flexibility and increases the slope of the NKPC.

Nevertheless, taking in account Theory of Firms research bring a special NKPC whose slope, γ is:

$$\gamma = \frac{\theta-1}{c_d}\frac{\theta_u-1}{c_u}\frac{1-\alpha+\psi+\sigma\alpha}{\alpha}$$

Here θu, the market structure of B2B firms, can seriously affect the standard relationship described above.

2.10 The Monetary Policy Rule

We will close the model by assuming a very simple monetary policy rule:

$$r_t = \phi \pi_t$$

A less simple monetary policy rule is useless ofr the purpose of the paper.

2.11 The Equilibrium

For sequence of productivity shocks $\{A_t\}_{t=0}^{\infty}$ a symetric equilibrium is a sequence of quantities:

$$\{\mathcal{Q}_t\}_{t=0}^{\infty} = \left\{Y_t, Y_t^n, \tilde{Y}_t, C_t, L_t, \Pi_t^d, \Pi_t^u, T_t\right\}_{t=0}^{\infty}$$

that satisfy households and firm optimality conditions for a given set of prices,

$$\{\mathcal{P}_t\}_{t=0}^{\infty} = \{W_t, P_t^u, P_t, r_t\}_{t=0}^{\infty}$$

2.12 The log linearised model around the steady state

Euler equation	$y_t = E_t y_{t+1} - \frac{1}{\sigma}\left(r_t - E_t \pi_{t+1}\right)$
Work Supply	$\psi l_t = w_t - \sigma y_t$
Output	$y_t = a_t + \alpha l_t$
Natural output	$y_t^n = \frac{\psi+1}{1-\alpha+\alpha\sigma+\psi} a_t$
Output gap	$\tilde{y}_t = y_t - y_t^n$
Optimal price for upstream firms	$p_t^{u*} = \frac{\theta_u - 1}{c_u} \frac{1-\alpha+\psi+\sigma\alpha}{\alpha} \tilde{y}_t + p_{t-1}^{u*}$
Inflation rate for upstream firm	$\pi_t^u = p_t^{u*} - p_{t-1}^{u*}$
New Keynesian Phillips curve for dowstream firms	$\pi_t = \frac{\theta-1}{c_d} \frac{\theta_u-1}{c_u} \frac{1-\alpha+\psi+\sigma\alpha}{\alpha} \tilde{y}_t + \frac{\theta-1}{c_d} p_{t-1}^{u*} + E_t \beta \pi_{t+1}$
Monetary policy rule	$r_t = \phi \pi_t$

Productivity shock in R&D and managment activities are relatively seldom, that's why the productivity parameter of downstream firms is not a big deal. The only shock is on the productivity parameter of upstream firms.

$$a_{t+1} = \rho a_t + \epsilon_t$$

avec

$$0 < \rho < 1$$

where ϵ_t is a white noise.

3 Results and simulations

3.1 Results

As explained before, the market structure of the upstream firms and the downstream firms depends on the value of γ :

$$\gamma = \frac{\theta - 1}{c_d}\frac{\theta_u - 1}{c_u}\frac{1 - \alpha + \psi + \sigma\alpha}{\alpha}$$

. To study the effect of market strucuture we will suppose that all the parameters remain constant since the beginning of the 1950's, except θ and θ_u. θ_u has definitively increased with Globalization: producers in B2B sector have suffered from competition of other OECD and emerging economies. In order to replicate the Great Moderation, i.e a move of the NKPC with consumer price index from the right to the left, the slope, γ, must decrease. Therefore we have no choice but to accept the assumption that the global rent have increase during the Great Moderation. In other words, the downstream elasticity of substitution must have decreased more than the rise of the uptream elasticity of substitution:

$$|\triangle\theta_u| < |\triangle\theta|$$

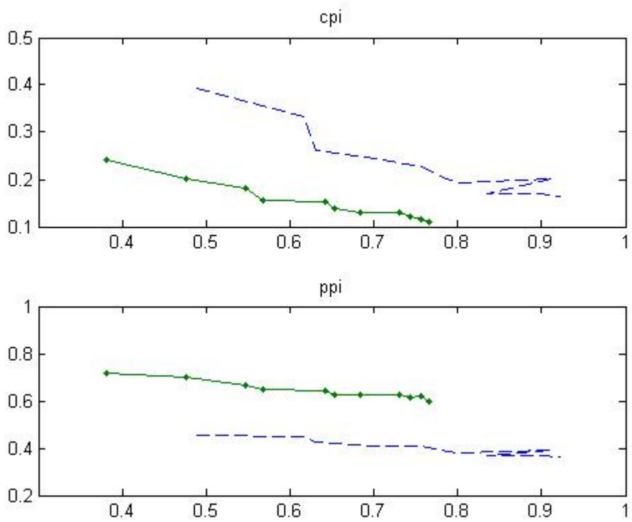
3.2 Calibration

The model is calibrated using usual values met in the Literature. The discount facor $\beta = 0.99$. Parameter $\alpha = 0.7$. Parameter$\psi = 2$ and parameter $\sigma = 2$. ρ is calibrated to 0.9. Parameter ϕ moves from 1,1 to 2,1. The model is not very sophisticated, that's why in order to meet output and inflation variability values met in [21] we have to use very high value of adjustment price cost: $c_u = 500$ and $c_d = 10000$.

3.3 Simulations

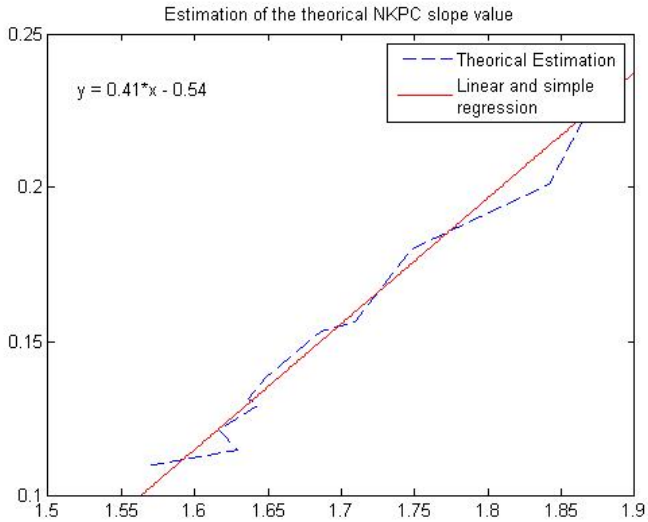
To illustrate the market structure of the upstream firm we will choose $\theta_u = 7$, before the Great Moderation and $\theta^u = 10$ during the Great Moderation. Concerning the downstream sector, $\theta = 10$ will decrease to $\theta = 4$ during the same periods. The first simulation illustrates moves of the trade-off between output and inflation volatilities.

Figure 5: Evolution of the NKPC for upstream (ppi) and downstream firms (cpi) before and during the Great Moderation



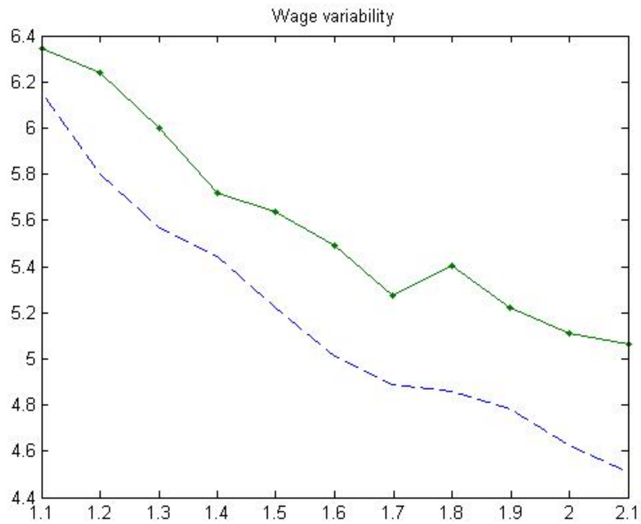
When we compute the value of parameter γ by a simple and linear regression, the theorical value of the NKPC slope varies around 0.4. The variable x represents the output gap volatility and the variable y is the consumer inflation volatiltity. [18] used a GMM method to estimate the empirical value of this slope for major OECD countries. He found values from 0 to 0.3 but he added lagged inflation and expected inflation in his regression. The model is relatively consistent.

Figure 6: NKPC illustration and equation for downstream firms during the Great Moderation



The next simulation shows a increase of the wage volatility, which is hightlighted in the empirical studies of [15],[17] but not explained by structural changes. According to the theory of Permanent Revenue, incentives to smooth consumption by enjoying credit services should have increased. This theory is consistent with the credit market development in all OECD countries since the begenning of the 1980's.

Figure 7: Standard deviation of wage for different monetary policies

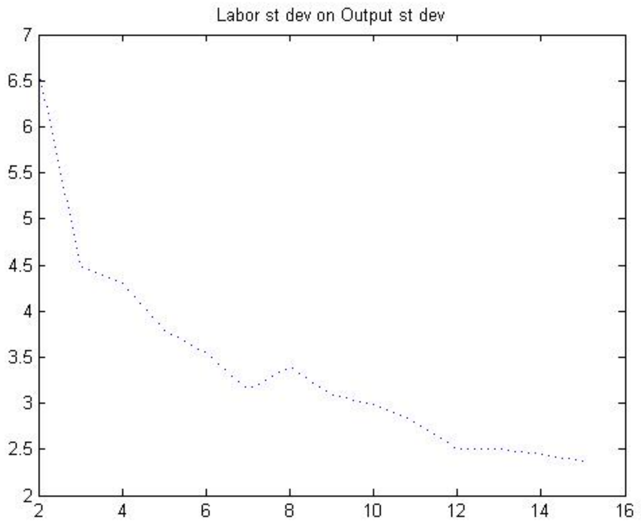


If we make θ decrease from 15 to 2 when $\theta_u = 15$ and $\phi = 1.5$, the model predicts that the volatility of employment relative to ouput increases when the gap between upstream and downstream elasticities of substitution increases, that is to say if we respect this assumption:

$$|\triangle\theta_u| < |\triangle\theta|$$

In [14], the standard deviation of worked hours relative to the output one increases too, but from 0.65 in 1965 to 0.84 in 2005. The simulation generate standard deviations between 2.5 and 6.5. However the labor market is here totally flexible. We can conclude that more the mark-up of the dowstream firm is high, higher is the variability of labor relative to output and higher the incentives to promote flexible labor markets.

Figure 8: Standard deviation of labor relative to the output standard deviation



However the model is weak because it predicts an increase in hours worked volatility, whereas [14] found a decrease. But two explanations arise about the limits of this model. First the mutation of big companies structure does not affect the whole OECD economy but only a large part of it. In the unaffected sectors the volatility of worked hours should lead the decreasing volatility of global output. Secondly the nature of jobs have changed a lot since the late 1970's. Accounting methods have evolved towards Activity Based Costing, since 1988 [3], which means that costs are more and more indirect and that hours worked volatility relatively to output have decreased. The present model just helps to understand why the decreasing volatility of worked hours is less important than the decreasing output volatility.

4 What concequences for an increase of global rent in OECD economies during the Great Moderation

By using the value of the wage at the steady state, it's possible to calculate its growth according to both elasticities of substitution:

$$\frac{\left[\frac{\frac{\delta W}{\delta t}}{W}\right]}{\left[\frac{\frac{\delta\left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\right)}{\delta t}}{\left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\right)}\right]} = -\left(\frac{1}{A_d A}\right)^{\frac{\psi}{\alpha}-\frac{(\psi+1)\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}} \left(\frac{1}{\alpha}\right)^{-\frac{\alpha\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}} \frac{\alpha\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha} \left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\right)^{-\frac{\alpha\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}-1} < 0$$

Because of the larger decrease of the downstream elasticity of substitution relative to the increasing upstream one, we find a explanation for the barely growth of the median wage relative to productivity growth during the Great Moderation in the United States and Canada, [16] Harrisson (2009). The increasing downstream mark-up may slows down the growth of the wage, the best 1% paid employees wages being incorporated to the profit. The increasing downstream mark-up is surely related to the increasing inequalities in OECD countries. But this model can't deal with this issue because we consider identical households. To finish, the rise in downstream firms profit could explain why no stagflation arised from recent oil price shock: greater profit can absorb a more important cost push shock without adjusting price.

5 Conclusion

If firms use high technology and very costly input, they may have increased their mark-up with Globalization. More traditionnal firms, often smaller ones, may have decreased their mark-up. The Great moderation has structural causes such as market power, which is possible to study through the reduced form of the NKPC obtained with the Calvo and Rotemberg price setting assumptions. The Calvo pricing fails to predict the increase of price volatility on BtoB markets where competition has definitively increased, notably in the manufactured product sector.
Therefore, we have used a simple New Keynesian model with upstream and downstream firms, where both are constraint by the Rotemberg price setting assumption. The only way to replicate the Great moderation is to assume an increase of the global markup. By our calibration, we replicate a theorical value of the NKPC close to the ones estimated by [18] for major OECD

economies.

Incentives for supporting a more flexible labor market and increasing wage volatility become endogeneous. A less competetive market gives an explanation of the barely growth of median wage, compare to the growth of global productivity during the period of the Great Moderation.

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A The Steady State Model

B Derivation of the NKPC under R model

When there is no price stickiness (c=0), both kind of firms charge its own mark-up over its current marginal cost

$$P_t = \frac{\theta}{\theta-1}\frac{P_t^{u*}}{A^d} = \frac{\theta}{\theta-1}\frac{1}{A^d}\frac{\theta^u}{\theta^u-1}\frac{1}{\alpha}W_t\left(\frac{1}{A_t}\right)^{\frac{1}{\alpha}}\left(Y_t^d\right)^{\frac{1}{\alpha}-1}$$

$$P_t = \frac{\theta}{\theta-1}\frac{\theta^u}{\theta^u-1}\frac{1}{\alpha}\left(\frac{1}{A^d}\right)^{\frac{1}{\alpha}+1}\left(\frac{1}{A_t}\right)^{\frac{1}{\alpha}}W_tY_t^{\frac{1}{\alpha}-1}$$

We can compute the steady state values of the model from these equations:

$$W = L^{\psi}C^{\sigma}$$

$$Y = A_dAL^{\alpha}$$

$$C = Y$$

$$1 = \frac{\theta}{\theta-1}\frac{\theta^u}{\theta^u-1}\frac{1}{\alpha}\left(\frac{1}{A^d}\right)^{\frac{1+\psi}{\alpha}+1}\left(\frac{1}{A_t}\right)^{\frac{1+\psi}{\alpha}}Y_t^{\frac{1+\psi}{\alpha}+\sigma-1}$$

we easily obtain:

$$Y = C = \left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\frac{1}{\alpha}\right)^{-\frac{\alpha}{\psi+\alpha\sigma+1-\alpha}}\left(\frac{1}{A_dA}\right)^{-\frac{(\psi+1)}{\psi+\alpha\sigma+1-\alpha}}$$

$$L = \frac{\left[\left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\frac{1}{\alpha}\right)^{-\frac{\alpha}{\psi+\alpha\sigma+1-\alpha}}\left(\frac{1}{A_dA}\right)^{-\frac{(\psi+1)}{\psi+\alpha\sigma+1-\alpha}}\right]}{A_dA}$$

$$W = \left(\frac{1}{A_d A}\right)^{\frac{\psi}{\alpha} - \frac{(\psi+1)\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}} \left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\frac{1}{\alpha}\right)^{-\frac{\alpha\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}}$$

Thanks to the last equation we can calculate the relation between wage growth and global mark-up:

$$\frac{\left[\frac{\frac{\delta W}{\delta t}}{W}\right]}{\left[\frac{\frac{\delta\left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\right)}{\delta t}}{\left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\right)}\right]} = -\left(\frac{1}{A_d A}\right)^{\frac{\psi}{\alpha} - \frac{(\psi+1)\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}} \left(\frac{1}{\alpha}\right)^{-\frac{\alpha\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}} \frac{\alpha\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}\left(\frac{\theta}{\theta-1}\frac{\theta_u}{\theta_u-1}\right)^{-\frac{\alpha\left(\frac{\psi}{\alpha}+\sigma\right)}{\psi+\alpha\sigma+1-\alpha}-1}$$

It's is now easy to find the natural output equation:

$$Y_t^n = \left[\frac{\theta-1}{\theta}\frac{\theta^u-1}{\theta^u}\alpha\left(A^d\right)^{\frac{1+\psi}{\alpha}+1}\right]^{\frac{1}{\frac{1+\psi}{\alpha}+\sigma-1}} (A_t)^{\frac{\psi+1}{1-\alpha+\alpha\sigma+\psi}}$$

Log-linearising the equation of the natural output gives:

$$y_t^n = \frac{\psi+1}{1-\alpha+\alpha\sigma+\psi}a_t$$

The efficient level of output, in the absence of technology shocks is

$$Y_t^e = 1$$

Because $T = 0$ at the steady state, The log-linearised aggregate ressource constraint with adjustment price cost is

$$y_t = c_t$$

at the symetric equilibrium the log-linearised marginal cost of upstream firms is

$$mcu_t = w_t - \frac{a_t}{\alpha} + \left(\frac{1}{\alpha}-1\right)y_t$$

which becomes

$$mcu_t = \left(\frac{1+\psi}{\alpha}\right)a_t + \left(\frac{1}{\alpha}-1+\frac{\psi}{\alpha}+\sigma\right)y_t$$

Then we easily obtain marginal cost of upstream firms according to the global output gap:

$$mcu_t = \frac{1-\alpha+\psi+\sigma\alpha}{\alpha}\left(y_t - y_t^n\right)$$

We can add the equation of the downstream marginal cost:

$$mc_t = p_t^{*u}$$

B.1 The upstream firms

A firm h chooses $\frac{P_t^u(h)}{P_t}$ to maximise the profit at each period t without forseeing.

$$P_t^u(h) Max \Pi_t^u(h) = \frac{P_t^u(h)}{P_t} Y_t^u(h) - \frac{W_t(h)}{P_t} L_t(h) - \frac{c_u}{2}\left(\frac{\frac{P_t^u(h)}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} - 1\right)^2 Y_t^u$$

which becomes:

$$P_t^u(h) Max \Pi_t^u(h) = \left(\frac{P_t^u(h)}{P_t}\right)\left(\frac{\frac{P_t^u(h)}{P_t}}{\frac{P_t^u}{P_t}}\right)^{-\theta_u} \frac{Y_t}{A^d}\int_0^1 \left(\frac{P_t^d(i)}{P_t}\right)^{-\theta} di - \left[\left(\frac{\frac{P_t^u(h)}{P_t}}{\frac{P_t^u}{P_t}}\right)^{-\theta_u} \frac{Y_t}{A^d A_t}\int_0^1 \left(\frac{P_t^d(i)}{P_t}\right)^{-\theta} di\right]^{\frac{1}{\alpha}} \frac{W_t(h)}{P_t} - \frac{c_u}{2}\left(\frac{\frac{P_t^u(h)}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} - 1\right)^2 \frac{Y_t}{A^d}$$

The Optimal condition is

$$(1-\theta^u)\frac{\left(\frac{P_t^{u*}(h)}{P_t}\right)^{-\theta_u}}{\left(\frac{P_t^u}{P_t}\right)^{1-\theta_u}}\frac{Y_t}{A^d} - \left(\frac{Y_t}{A^d A_t}\right)^{\frac{1}{\alpha}}\left(-\frac{\theta_u}{\alpha}\right)\frac{\left(\frac{P_t^{u*}(h)}{P_t}\right)^{-\frac{\theta_u}{\alpha}-1}}{\left(\frac{P_t^u}{P_t}\right)^{\frac{-\theta_u}{\alpha}}}\frac{W_t(h)}{P_t}$$
$$-c_u\left(\frac{\frac{P_t^u(h)}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} - 1\right)\frac{Y_t}{A^d}\frac{1}{\pi \frac{P_{t-1}^u}{P_{t-1}}(h)} = 0$$

which becomes at the symetric equilibrium:

$$\frac{c_u}{\theta_u}\left(\left(\frac{\frac{P_t^u}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}}\right)^2 - \frac{\frac{P_t^u}{P_t}}{\pi \frac{P_{t-1}^u}{P_{t-1}}}\right) = \frac{(1-\theta_u)}{\theta_u} + \frac{1}{\alpha}\frac{W_t}{P_t}\left(\frac{1}{A^d A_t}\right)^{\frac{1}{\alpha}} Y_t^{\frac{1}{\alpha}-1}$$

Loglinearising gives:

$$\frac{c_u}{\theta_u}\left(2\frac{p_t^u}{p_t} - 2\frac{p_{t-1}^u}{p_{t-1}} - \frac{p_t^u}{p_t} + \frac{p_{t-1}^u}{p_{t-1}}\right) = \frac{(\theta_u - 1)}{\theta_u} mcu_t$$

and finally

$$p_t^u - p_{t-1}^u = \frac{\theta_u - 1}{c_u}\frac{1-\alpha+\psi+\sigma\alpha}{\alpha}\left(y_t - y_t^n\right) + -p_{t-1}^u$$

B.2 The downstream firms

For downstream firms, the information is perfect. A firm i chooses $\frac{P_t^d(i)}{P_t}$ to maximise the profit at each period t.

$$P_t^d(i) Max \Pi_t^d(i) = E_t\left[\sum_{s=t}^{\infty} R_{t+s}\left(\frac{P_{t+s}^d(i)}{P_{t+s}}Y_{t+s}(i) - \frac{P_{t+s}^u(i)}{P_{t+s}}Y_{t+s}^d(i) - \frac{c_d}{2}\left(\frac{P_{t+s}^d(i)}{\pi P_{t+s-1}^d(i)} - 1\right)^2 Y_{t+s} - L_{hs}(i)\right)\right]$$

which becomes:

$$P_t^d(i) Max \Pi_t^d(i) = E_t\sum_{s=t}^{\infty} R_{t+s}\left(\frac{P_{t+s}^d(i)}{P_{t+s}}\left(\frac{P_{t+s}^d(i)}{P_{t+s}}\right)^{-\theta} Y_{t+s}(i) - \frac{P_{t+s}^u(i)}{P_{t+s}}\left(\frac{P_{t+s}^d(i)}{P_{t+s}}\right)^{-\theta}\frac{Y_{t+s}(i)}{A^d} - \right.$$
$$\left.\frac{c_d}{2}\left(\frac{P_{t+s}^d(i)}{\pi P_{t+s-1}^d(i)} - 1\right)^2 Y_{t+s} - L_{hs}(i)\right)$$

The first order condition is:

$$R_t(1-\theta)\frac{{P_t^{d*}}^{-\theta}(i)}{P_t^{1-\theta}}Y_t + R_t\frac{Y_t}{A^d}\frac{P_t^u(i)}{P_t}\theta\frac{{P_t^{d*}}^{-\theta-1}(i)}{P_t^{-\theta}} - R_t c_d\left(\frac{P_t^{d*}(i)}{\pi P_{t-1}^d(i)} - 1\right)Y_t\frac{1}{\pi P_{t-1}^d(i)} +$$
$$E_t R_{t+1} c_d\left(\frac{P_{t+1}^d(i)}{\pi P_t^{d*}(i)} - 1\right)Y_{t+1}\frac{P_{t+1}^d(i)}{\pi {P_t^{d*}}^2(i)} = 0$$

then

$$\frac{1-\theta}{\theta} + \frac{1}{A^d}\frac{P_t^u(i)}{P_t}\frac{{P_t^{d*}}^{-1}(i)}{P_t^{-1}} - \frac{c_d}{\theta}\left(\frac{P_t^{d*}(i)}{\pi P_{t-1}^d(i)} - 1\right)\frac{1}{\pi P_{t-1}^d(i)}\frac{{P_t^{d*}}^{\theta}(i)}{P_t^{\theta-1}} +$$
$$E_t\frac{R_{t+1}}{R_t}\frac{c_d}{\theta}\left(\frac{P_{t+1}^d(i)}{\pi P_t^{d*}(i)} - 1\right)\frac{Y_{t+1}}{Y_t}\frac{P_{t+1}^d(i)}{\pi {P_t^{d*}}^2(i)}\frac{{P_t^{d*}}^{\theta}(i)}{P_t^{\theta-1}} = 0$$

then

$$\frac{1-\theta}{\theta} + \frac{1}{A^d}\frac{P_t^u(i)}{P_t}\frac{{P_t^{d*}}^{-1}(i)}{P_t^{-1}} - \frac{c_d}{\theta}\left(\frac{P_t^{d*}(i)}{\pi P_{t-1}^d(i)} - 1\right)\frac{1}{\pi P_{t-1}^d(i)}\frac{{P_t^{d*}}^{\theta}(i)}{P_t^{\theta-1}} +$$
$$E_t\frac{R_{t+1}}{R_t}\frac{c_d}{\theta}\left(\frac{P_{t+1}^d(i)}{\pi P_t^{d*}(i)} - 1\right)\frac{Y_{t+1}}{Y_t}\frac{P_{t+1}^{d*}(i)}{\pi {P_t^{d}}^2(i)}\frac{{P_t^{d*}}^{\theta}(i)}{P_t^{\theta-1}} = 0$$

At the symetric equilibrium it becomes:

$$\frac{1-\theta}{\theta} + \frac{1}{A^d}\frac{P_t^u}{P_t} - \frac{c_d}{\theta}\left(\left(\frac{\pi_t}{\pi} - 1\right)\frac{\pi_t}{\pi} + \beta E_t\left(\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\left(\frac{\pi_{t+1}}{\pi} - 1\right)\frac{\pi_{t+1}}{\pi}\frac{Y_{t+1}}{Y_t}\right)\right) = 0$$

or

$$P_t = \frac{1}{\frac{\theta-1}{\theta} + \frac{c_d}{\theta}\left(\left(\frac{\pi_t}{\pi} - 1\right)\frac{\pi_t}{\pi} + \beta E_t \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\left(\frac{\pi_{t+1}}{\pi} - 1\right)\frac{\pi_{t+1}}{\pi}\frac{Y_{t+1}}{Y_t}\right)} \frac{P_t^u(i)}{A^d} = \mu_t \frac{P_t^u(i)}{A^d}$$

Loglinearizing this equation gives:

$$\frac{c_d}{\theta}\left(\pi_t - \beta E_t \pi_{t+1}\right) = \frac{(\theta-1)}{\theta} mc_t$$

We finally obtain:

$$\pi_t = \frac{\theta-1}{c_d}\frac{\theta_u - 1}{c_u}\frac{1-\alpha+\psi+\sigma\alpha}{\alpha}\tilde{y}_t + \frac{\theta-1}{c_d} p_{t-1}^{u*} + E_t \beta \pi_{t+1}$$