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Modelling Education Dynamics with Cliometric Foundations

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Abstract: *The numerous analogies in the literature on economics between monetary theory and education policy lead me to propose a new model inspired by the work of Dornbusch [1976] and transposed to a context of 'diploma inflation'. Supposing the required job skills rigid in the short run, I show a significant over-education phenomenon and an overshooting of the wage penalties in starting jobs. After formal education has been completed, the new graduate cohorts, despite a more significant level of initial training and better salary prospects have to face, paradoxically and in comparison with the previous generations, a higher over-education extent over a long period.*

Keywords: Overshooting; Over-education; Education Economics; Economic Policy, Political Economy, Macroeconomic Dynamics, Cliometrics.

JEL-classification: D31, I20, J31, N3.

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Introduction

The idea of misadjustment between the supply and demand of education is central in the economic (Freeman, 1971, 1976; Hartog, 2000) and cliometric (Diebolt, 2001, 2015, 2016) literature[2] (Appendix 1) on 'over-education'. I use this idea as the starting point for drawing a parallel between monetary and education signals. As supply and demand for liquidity determines the value of a currency, I put forward the hypothesis that the differential between supply and demand for skills sets the value of education degrees. Following this intuition, I developed a simple over-adjustment model as an extension of the work on 'overshooting' by Dornbusch (1976). I adapt this monetary model using three major theories in education economics: the filter approach (Spence, 1973 and Arrow, 1973), the human capital theory and the model for jobs competition (Thurow, 1975).

The dynamics of this formalisation is based on the core hypothesis that the adjustment of demand to the supply of qualifications is slow. The rigidity of demand for skills results in a high risk of downgrading at recruitment for the increasingly well-qualified persons leaving the educational system. The imbalance between training and employment thus replaces direct adjustment via salaries. Downgrading would appear to be '*a procedure for the flexibilisation of the cost of labour that may replace adjustment by wage*s' (Forgeot and Gautié 1997).

In the model, I first assume implicitly that qualification for the jobs available on the labour market is determined exogenously, that is to say independently of the general levels of qualifications of the applicants. The 'hierarchic distribution' (Passeron, 1982) of the population by school qualifications is neutral with regard to the 'hierarchic distribution' of the jobs available on the labour market. However, this hypothesis is incorporated in my formalisation in the second version of the model.

This article is therefore aimed at analysing the conditions of access to employment for a cohort of diploma holders at initial higher education level. In other words, I seek to understand how the economy absorbs the lengthening of the duration of education. The first section of the paper consists of a brief reminder of the logic of the filter theory and that of human capital theory. In the second section, an analytical solution to the evolution of wages[3]

[2]For a survey of the over-education literature, see McGuiness (2006).

[3]And indirectly to the downgrading of diplomas or the decrease in the yield of education. The phenomenon was observed in France over a long period by Baudelot and Glaude (1989) and then by Goux and Maurin (1994).

in time and downgrading at recruitment is developed. Graphic interpretation of the mechanisms explained in my formal approach is provided in the last section. Finally, I conclude by determining the optimum rate of convergence towards equilibrium on a perfectly flexible labour market, *ceteris paribus*.

1. Human capital theory versus filter theory

Human capital theory basically assumes that individuals are paid according to their productivity and that this is determined by human capital (education, training, experience, etc.) more than by the characteristics of the occupation (Becker, 1975). With the neoclassic hypotheses of information and perfect competition, the labour market is assumed to be efficient, with firms making full use of the productive capacity of their labour force. Employees' incomes are therefore mainly a function of the supply of degrees and the yield of education independent of situations of poor matching of training and the employment of individual persons.

However, orthodox human capital theory does envisage the existence of over-education situations in which the investment of individuals in education goes beyond qualified labour requirements. Excess supplies from the educational system resulting in a comparative decrease in wages on the labour market encourages individuals to reduce their investment in education and firms —that seek maximum profits— adapt their production technology. Thus the simultaneous adjustment of supply and demand for qualified labour (Freeman, 1976) results in the natural correction of the imbalance, which remains transitory (the 'reversible' character of over-education).

The common idea of the 'filter' model is to consider education as a signal. In theory, higher wages will be given to the best educated workers as they are, *a priori*, the most productive, even if education itself does not increase productivity. Unlike human capital theory, the 'filter' approach shows in this hypothesis the interest of certain persons to join forces to stand out from the others[4]. Assuming a relative imperfection of degrees, that is to say that for an employer the competency of a worker is not necessarily identified with the degree, individuals are then encouraged to increasingly do investments in education, creating

[4] '*Testing and certifying is nothing more nor less than self-licensing* ' (Spence, 1974, p. 58).

a 'race for qualifications' phenomenon. Thus, in contrast with human capital theory, the filter approach underlines the possibility of a situation of lasting saturation of demand for qualified persons (the 'irreversible' character of over-education).

However, although human capital theory and the 'filter' model are often assumed to be alternatives, the hypothesis of the complementarity of the two approaches would seem more realistic. If the production system is considered to be a 'production filter' (Lemistre, 2003), initial training contributes to the acquisition of abilities and a degree makes it possible to identify both these intrinsic skills and those acquired during initial training (Riley, 1976 and Blaug, 1982). From this angle, my theoretical model is based on both human capital theory and the filter approach. More precisely, it makes it possible to compare the 'reversible' (transitory) or 'irreversible' (permanent) character of over-education at hiring.

2. The model with market rigidity

For previous generations and for a given job, I assume that wages and wage penalties resulting from over-education are exogenous in the short term. The market conditions are first defined and then the behaviour of employers.

2.1 The diploma market

Assumption 1. In the competition for jobs model (Thurow, 1975), employers recruit the applicants at the top of the 'labor queue'. This automatically leads to the hiring of overeducated workers. In Thurow's approach wages are predetermined, being rigid for short periods but increasing with the use of professional experience and the period spent working for the employer.

In this hypothesis, the over-education phases during a professional career form part of the procedure of integration in the labour market (Guironnet, 2006) and compensate the lack of professional experience. Over-education is considered to result from the poor matching of the worker and his/her job which is a provisional stage in his/her career during which the qualities gained in a low level job are useful later in another position (Sicherman, 1991). In other words, eligibility for a job requires larger amounts of initial training when there has

been little professional experience. This substitutability between different forms of human capital generates a trend for the inflation of diplomas (snowball effect).

Wage penalties caused by the over-education phenomenon are measured by *p*. Equation (1) is the "uncovered pay parity" between graduate cohorts:

$$s = s^* + \theta(\overline{p} - p) \qquad [1]$$

$\overline{p}$ is the long term, the 'irreversible' wage penalties (filter theory) towards which the economy must converge so that $p > \overline{p}$ whereas $p - \overline{p}$ represents the 'reversible' short-term loss of wages (human capital theory). s is the salaries of new cohort and s^* that of oldest generations, so that $s < s^*.\theta$ is the adjustment coefficient of the market (assumed to be fixed). The wage differential between older and new generations is explained directly by the devaluation of degrees, $\overline{p}$ (Jarousse and Mingat, 1986) and indirectly by short-term devaluation, p, that in turn influences long-term devaluation.

Adaptation on the demand side is rigid in this context, in other words the supply of degree-holders is considered as neutral with regard to the distribution of positions. This hypothesis is made more flexible in the second version of the model.

Assumption 2. The employer is convinced that a discrimination level of training exists[5] (Spence, 1973). For a student, this assumption implies a minimum level (or required level) of education (signals for the job market) to get the job.[6]

Demand depends positively on the real qualification needed for the job, *n*, and negatively on the new cohort wages. Graduate supply[7] represents the years of cohort education, *e*, minus the required years of education for the job candidate, *r*. At equilibrium, supply of graduates matches demand:

$$\phi n - \lambda s = e - r \qquad [2]$$

[5]It is equivalent to considering a university as a filter (Arrow, 1973).

[6]For a test of the signalling value of education in a context of overeducation, see Chatterji *et al.* (2003).

[7]Supply does not include unemployed graduates: the employment shortage is assumed to be neutral with regard to the over-education phenomenon.

Combining (1) and (2) gives:

$$\phi n - \lambda\theta(\bar{p} - p) - \lambda s^* = e - r \qquad [3]$$

In the long-term equilibrium, equation (3) is simplified by considering an identical wage penalty[8] between generations. The discriminating level of training over a long period, $\bar{r}$, is expressed as follows:

$$\bar{r} = e - \phi n + \lambda s^* \qquad [4]$$

Substituting (4) for (3) gives the evolution of wage penalties after the shock of the cohort entry with higher level of education (*de*):

$$p - \bar{p} = -(1/\lambda\theta)(r - \bar{r}) \qquad [5]$$

For a given wage level, equation (5) represents the wage penalty differential with the required levels of education. An increase in *r* causes degree depreciation and proportionally reduces the wage penalties[9].

2.2 The real sector

Real (i.e. relative) wage penalties for the new cohorts are given by $p - p^*$, with p^* being the wage penalties of previous generations. Under these conditions, the skills demanded depends on the relative wage penalties and salaries of young graduates and the real need for job qualification.

$$n^D = \gamma n - \eta s + \delta(p - p^*) \qquad [6]$$

[8]In other words, the wage losses resulting from the over-education phenomenon: this can also be an indicator of the extent of downgrading on hiring (Nauze-Fichet and Tomasini, 2002; Jensen, 2003; Guironnet and Peypoch, 2007).

[9]Graphically, this result is represented by a line slope $-\lambda/\theta < 0$ of market equilibrium of a diploma.

In a context of surplus supply from the education system, the employers who select the persons at the top of the 'labor queue' recruit overeducated workers (see Assumption 1). This trend is also accentuated by 'mimicry[10]' phenomena among employers (Fondeur, 1999). If the level of training is considered as a signal of adaptability to employment (Thurow, 1975), employing over-qualified workers reduces the cost of adaptation involved in future technological innovations. Here, technical progress is an exogenous factor that can absorb part of the over-education (Guironnet and Peypoch, 2007): over a long period, employers change the levels required for employment in the light of the new skills required for implementing new production technology.

For the new generation, I assume that the increase in the minimum level of training is represented in (7) as being proportional to the excess skills demanded compared to the real requirements for job qualification[11], in other words to an increase in the imbalance between training and employment:

$$\dot{r} = \psi \ln(N^D / N) = \psi(n^D - n) = \psi[\delta(p - p^*) - \eta s + (\gamma - 1)n] \qquad [7]$$

In the long run, the adjustment equation of the required level of education (7) is simplified and the wage penalties of the long-term equilibrium are expressed as:

$$\bar{p} = p^* + (1/\delta)[(1-\gamma)n + \eta s^*] \qquad [8]$$

The long period equilibrium of wage penalties remains higher than the initial level p^*. In terms of mismatch, the new cohort does not attain the initial level of the previous generations. Thus, permanent excess supply of graduates causes increasing depreciation of the educational signals: for a given degree, the new workers have lower probability of access to the top jobs in the professional hierarchy.

[10]To continue our analogy, the effects of 'mimicry' are also found in theories of exchange rate forecasting.

[11]Represented by a positive slope of the equilibrium line on the real market.

Proposition: Adjustment of the required level of education is a function of the structural parameters of the model (see Appendix 2).

$$\dot{r} = -v(r - \bar{r}) \text{ avec } v = \psi[(\delta / \lambda\theta) + (1/\lambda)] \quad [9]$$

With $v>0$ and $(r - \bar{r}) < 0$, I obtain $\dot{r} > 0$.

The solution of the first degree linear differential equation (9) gives:

$$r(t) = \bar{r} + (r_0 - \bar{r})\exp(-vt) \quad [10]$$

The replacement of *r* by *r(t)* in (5) determines the temporal evolution of wage penalties:

$$\begin{aligned} p(t) &= \bar{p} - (1/\lambda\theta)(r_0 - \bar{r})\exp(-vt) \\ &= \bar{p} + (p_0 - \bar{p})\exp(-vt) \end{aligned} \quad [11]$$

(10) and (11) are used in the next section to represent the temporal dynamics of wage penalties and the education required for the new cohort.

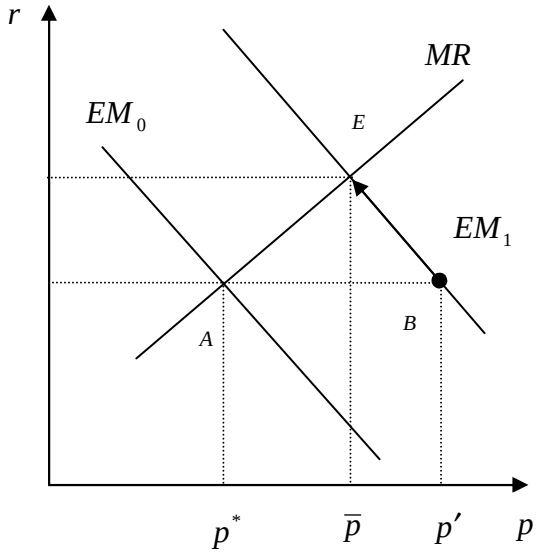
3. GRAPHIC INTERPRETATION

The equilibrium curves in the real sector and diploma market are noted (*MR*) and (*EM*) respectively. An increase in the supply of graduates over a long period causes a proportional increase in wage penalties without any changes in the education required.

Economic evolution is represented (Fig. 1) by the arbitrary setting of an initial level of equilibrium (p^*, r^*).With the economy initially at equilibrium *A*, an increase in graduate supply moves the potential equilibrium of the diploma market from (EM_0) to (EM_1). However, because the required level of education is rigid in the short term, many new workers

are overeducated by employers' overestimation of skill requirements. The shock (*de*) implies an overshoot of wage penalties until p', I are[12] at the short run equilibrium (point *B*).

Fig. 1. Dynamics with a surplus supply of diploma-holders



In the long run, with an increasingly high required level of education, the proportion of overeducated workers decreases. The economy converges towards a new equilibrium *E* while wage penalties decrease until $\bar{p}$. The situation for new graduates is not the same as for previous generations: the supply surplus of human capital causes a decrease in education returns. A proportion of workers remains overeducated at the end of the process. Over-education is a long-term phenomenon but may well be a short-term one for certain persons (Rubb, 2003).

This type of dynamics confirms the diminishing trend of education returns observed in recent decades in most developed countries (Sloane, 2003). This perpetual process causes a steady decrease in appropriate jobs (jobs for which a person considers that he/she is suitable) for increasingly highly trained young degree-holders, that is to say further lowering of the probability of access to senior positions in the professional hierarchy.

[12]The changes in situations in the economy are ascribed mainly to changes in the downgrading (and wages) situation of the new cohort of diploma-holders. The rest of the labour force is considered as being exogenous in our formalisation and its situation is not changed.

Using (3), I deduce the impact of the expansion of the graduate workforce on the wages penalties of new cohorts:

$$dp / de = 1 + 1/\lambda\theta \qquad [12]$$

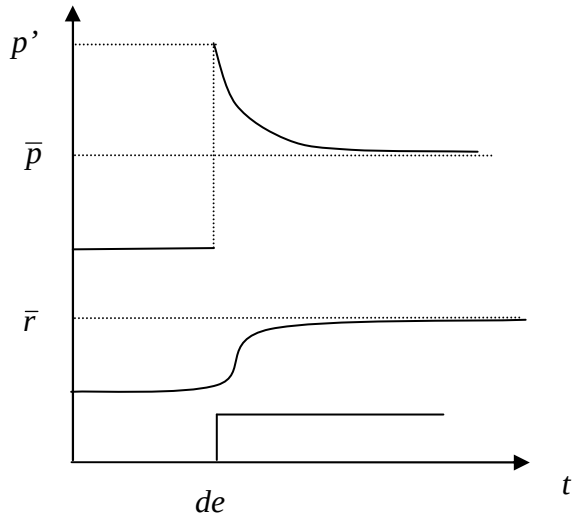
This gives the following equalities for the coordinates of the points in Figure 1:

$$\begin{cases} \bar{e} = e^* + de \\ \bar{p} = p^* + de \\ p' = p^* + de + de/\lambda\theta \end{cases} \qquad [13]$$

More precise analysis of the trend in wage penalties and the training level required for the new cohort gives a better idea of the dynamics of all the generations (see Figure 2).

A wage penalty at level p^* is assumed for the preceding generations. The resulting shock *(de)* causes a readjustment of the losses of the new cohort in relation to this level. The over-education extent of the new cohort will adjust with experience and time in employment and decrease to $\bar{p}$. Meanwhile, the levels required will increase to $\bar{r}$, the new long-term equilibrium.

Figure 2. Temporal dynamics



4. The optimum growth pathway

In this version of the model, the 'hierarchic distribution' of the population by level of degree causes a reaction on the demand for qualifications side. Anticipating the general lengthening of the duration of education (*de*), employers propose a required optimum level of education[13] for vacant jobs for the quickest abatement of the unfavourable effect of poor matching of training and employment. The hypothesis of short-term adaptation of individuals to employment requirements made in Thurow's approach (1975) is thus reversed over a long period as employers adapt their demand for skills to the continuous increase in education levels (Lemistre, 2007). To the best of my knowledge, only Bruniaux's study (2001) shows such evolution, with adaptation of demand to the supply of skills in the banking sector in several European countries.

Although education does not only respond to the needs for skills in the production system, the main objective of educational policies in numerous countries is to increase competitiveness in the long term. This effect is often modelled in the form of 'positive externalities' (Romer, [1990]), contrasting with our approach that considers this component as endogenous.

According to (10) and (11), the rate of convergence towards equilibrium, of reclassification and wages depends on *v*. According to (9), adjustment to equilibrium is a function of the coefficient θ. In other words, the perfect market with faster adjustment dynamics must verify $\theta = v$. In this framework, coefficient θ then corresponds to perfect matching of demand from the labour market and therefore verifies:

$$\theta = v \equiv \psi[(\delta / \lambda\theta) + (1/\lambda)] \qquad [14]$$

I obtain perfect anticipations $\tilde{\theta}$, by solving (15), as a function of the structural parameters of the economy.

$$\tilde{\theta}(\lambda, \delta, \eta, \psi) = \psi / 2\lambda + [(\psi^2 / 4\lambda) + \psi\delta]^{\frac{1}{2}} \qquad [15]$$

[13]The capacity for implementing new technologies is probably proportional to the level of the degree (Bartel and Lichtenberg, 1987).

For stability conditions, equation (15) represents the positive root of quadratic equation (14). Assuming a perfectly flexible market, the latter equation gives the speed of adjustment at which the market converges towards long-term equilibrium. This convergence pathway is the most rapid adjustment of the economy and coefficient θ is no longer exogenous but depends on the scale of the 'training-employment' imbalances. Substantial over-education combined with a substantial penalty of wages triggers as a response optimum demand according to the structural parameters of the market. In other words, this version of the model makes assumption 2 considerably more flexible. The shock caused by the newcomers on the labour market does not have an instant effect on 'hierarchic distribution' of the positions to be filled but results in the perfect matching of demand for qualifications over a long period.

Although the framework of this version of the model can still be disputed, it is nonetheless of interest. Indeed, this increased flexibility of the labour market would allow 'fairer' job distribution, with each person able to lose his/her job on the arrival of a more competent newcomer[14].

Conclusion

The hypothesis of the ‘diplomas inflation’ resulting from work on over-education matches my model. On completion of their education, young people do not experience the situation of past generations. Their general downgrading is greater.

Following this dynamics, the continuous increase in differences between supply and demand for degrees may explain the structural increase of the over-education phenomenon. With the over-adjustment of wage losses in first jobs and in spite of a readjustment of wages over a long period, young qualified persons are not in the initial situation experienced by their elders: the decrease in the education return becomes more marked and is partially 'irreversible'.

[14]An insider-outsider approach, with newcomers considered as outsiders (no job security) and the older generations as insiders (stable jobs).

In this context, I consider that (at least) two solutions are possible: either an adaptation of demand or regulation of the supply of education. With regard to supply, a comparative shortage of degree-holders might favour a readjustment and reduction in the scale of over-education (Gamel, 2000b). With their recent statutory independence, an essential mission of monetary authorities is to prevent inflation by adjusting the growth of the money supply to the strict liquidity requirements of countries. Following my analogy, in spite of their lack of independence, should not education policies also regulate the long-term growth of the flow of degree-holders according to the comparative scarcity of qualifications in the economy?

However, adaptation of the demand side is no less necessary, as is suggested in the last part of this article. By acting on the speed of the readjustment of 'training-employment' imbalances, the over-education phenomenon may be 'reversible', assuming that demand is flexible (Lemistre, 2003). A more intermediate solution also seems possible and would consist of adaptation of both supply and demand for skills.

Education policies justify their action by the equality of opportunity in access to knowledge. However, would not the continued depreciation process compromise the future? From a sociological viewpoint, another unfavourable effect can be observed: overeducation seems to produce a decline in the cognitive abilities of the worker, lesser job satisfaction, etc.

Appendix 1

Over time, demand for education has grown progressively from primary to secondary and then to higher education. At each stage it has developed its own dynamic, but with little political pressure each has led on to system growth at the next level. At the same time, the dynamics of the teaching system seem to have upset established trends, creating a separation between it, the qualification process and the demand for labour.

For over a century and a half at German and Prussian universities, for example, there have been cyclical phases of saturation and shortage in the numbers of students enrolled. How do I explain this? What new understanding of the long-term relationship between education and the labour market can I provide? What proposals should be made to guide educational policy and inform economic policy so as to contain unemployment?

The production of new statistical series has enabled new lines of enquiry. These describe the social origins of students, attendance patterns, occupational destinations, incomes, etc. Applied to the German case, such data have made it possible to put forward a twin hypothesis. First, student choice of curriculum is affected by expected rewards, with the allocation of students to faculties dependent on the comparative yields of the latter, in terms of expected earnings and job availability in corresponding professional sectors. Expected student rewards are represented (i) by earnings on the labour market at a given moment and (ii) by what they consider attainable over time. In addition, when a shortage occurs in different sectors of the professional labour market, we can replace data for occupational earnings with an attraction effect associated with selected programmes of study. Once the shortage has been made up, the demand effect continues as a result of lagged situational perceptions on the part of young people. Gradually, this may lead to the over-production of qualified university leavers, relative to labour market demand. This imbalance diverts potential new cohorts of students to other sectors of education or directly to the labour market. It causes a new skill shortage, leading to a cyclical pattern modulated according to job availability.

My cliometric work (partial equilibrium model, translog function, cobweb model, etc.) shows that throughout the period of our statistical window, 1820-1941, elasticities display a net and gross substitutability effect between university programmes and the professions. In concrete terms, the effect of the substitutability between two faculties H and J, means that the number of students enrolled at H moves in the opposite direction to the expected earnings in J. Their own positive elasticities were also observed, highlighting the synchronous movement of student numbers (at the universities and in the professions) and their respective yields. There are three explanations for this. The first is student behaviour when choosing a programme, governed by expected earnings. Second, professional ageing may create a substantial demand for young graduates. Numerous vacancies may also explain such demand. When the three phenomena coincide, their effect on the rising generation is cumulative and forms a particularly strong attraction phenomenon. This acts on layers of the population which, because of their lowly social position, try to seize the opportunities created to enter professions in which there is a skill shortage. Thus each career is momentarily open to the social classes most remote from university training, before closing again once the opportunities are taken. Considering the interaction of these different mechanisms, it can be seen that, in the long-term, student numbers are kept in a fluctuating equilibrium.

Each faculty enrolment cycle lasts about 25 years. This is at least twice the length of professional training, even with the addition of the years required to eliminate shortage and glut. In this situation, it is easy to see how periods of shortage lend themselves to accelerated change, since a shortfall in a specific area leads to greater mobility of both those exercising the profession and those aspiring to it.

Appendix 2

Proof of the proposition:

To obtain (9), I substitute (8) in (7):

$$\dot{r} = \psi[\delta(p - \bar{p}) - \eta(s^* - s)] \qquad [A1]$$

With $s - s^* = \theta(\bar{p} - p)$ and replacing this by (5) in (A1), the following is obtained:

$$\dot{r} = -\psi[(\delta / \lambda\theta) + 1/\lambda](r - \bar{r}) \qquad [A2]$$

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