CENTRE FOR RESEARCH ON GLOBALISATION AND LABOUR MARKETS

Research Paper 99/13

Trade and Labour Rents: An Analysis of the Recent OECD Wage Inequality and Unemployment Experience

by

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The Centre acknowledges financial support from The Leverhulme Trust under Programme Grant F114/BF

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Acknowledgements

The author would like to Jeffrey Sheen, Alan Woodland, Don Wright, Peter Neary, Deborah Cobb-Clark and Indraneel Dasgupta for comments at various stages of this research.

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Abstract

There has been much discussion of increased wage dispersion and unemployment across the OECD over the last two decades. This paper suggests an explanation of these trends based on the effect of international trade on labour rents extracted as a result of the existence of hiring and firing costs. Unlike the standard Stolper-Samuelson trade explanation of the trends it can account for rising relative skilled wages at the same time as rising skilled labour intensity of production, and unskilled unemployment. Considering differences in labour market institutions, the model is also able to shed some light on the differences between US and European experiences over the period.

Outline

1 Introduction

An issue which has rightly been absorbing the attention of economists has been the increase in earnings dispersion across the OECD over the past two decades. In many OECD countries there has also been high and rising unemployment. Apart from general humanitarian, fairness and social cohesion issues, the developments directly concern economists because of the shadow they cast over trade and immigration policy. The facts and concerns have been documented by Wood (1994), Freeman and Katz (1995), Richardson (1995), Krugman (1995), Leamer (1996a,1996b), Lawrence (1996), Rodrick (1997) and many others.

This paper is a contribution to better understanding the causes of the changes in wage dispersion and unemployment across the OECD[1]. An alternative to the Stolper-Samuelson trade explanation will be offered, where trade impacts labour rents, with general equilibrium feedback effects on the allocation of resources and employment. Some previously puzzling features of the developments can then be understood, as can the variation in the effects of the common trade changes in different parts of the OECD.

Before considering the model in the next section, it will be helpful to discuss the Stolper-Samuelson trade explanation of these developments, and some of its problems. It has been argued (most strongly by Wood 1994,1995) that the growth of low skill intensive manufacturing in developing countries has increased the world supply of unskilled labour intensive manufactured products these products and lowered their relative price on world markets[2]. In a standard competitive full employment model of a small trading economy, with skilled and unskilled labour the factors of production, the Stolper-Samuelson theorem says this world price change will increase skilled wages and reduce unskilled wages.

Initially the doubts about the Stolper-Samuelson explanation were that evidence of change in relative world prices was only weak. The early empirical studies failed to find large changes in relative prices (Laurence and Slaughter 1993, Sachs and Shatz 1994), but more recent work has identified significant declines in the relative world prices of goods which use unskilled

[1] I take the central fact to be explained as increased dispersion of wages. Other writers have considered particular manifestations of this increased dispersion, for instance high/school college wage premiums, unskilled vs skilled wages, production vs nonproduction wages.

[2] A trade based explanation is also suggested by the increase in low skill intensive imports (for instance Borjas, Freeman and Katz 1992, Wood 1994 1995) but the interpretation of such quantity evidence in relation to price evidence has been the subject of much debate among labour economists and trade economists.

labour relatively intensively (Sachs and Shatz 1996, Leamer 1996a 1996b). Sachs and Shatz (1996p238), based on a more comprehensive study than their earlier paper and an assessment of other subsequent studies, are now emphatic about the relative world price changes, stating "relative value-added prices of low-skilled intensive products have in fact declined markedly during the period 1979-1990 …[and this] has continued during 1990-1995". This doubt now seems resolved.

There are still two unresolved problems with the Stolper-Samuelson trade explanation of the trends. Firstly, the model from which the theorem comes is a full employment model, so it cannot simultaneously explain the wage and unemployment changes. It can be shown that the Stolper-Samuelson result carries over to a model with minimum wage unemployment and the minimum wage model has begun to be applied to the issue by Krugman (1995) and Davis (1998a) so this problem appears resolvable. The second, more serious problem is that the Stolper-Samuelson effect on relative wages brings with it with a change in the factor intensity of production, so that all industries should become more unskilled labour intensive. The empirical evidence (for instance Krugman and Lawrence 1994, Lawrence 1996) is sharply inconsistent with this implication of explanation, showing little change in factor intensity or a change in the opposite direction.

These unresolved problems with the Stolper-Samuelson have contributed to trade based explanations losing ground to explanations based on technological change (e.g. Berman, Bound and Griliches 1994; Berman, Bound and Machin 1997), failures of education systems (Nickell and Bell 1996), lack of incentives for human capital formation (Heckman, Lochner and Taber 1998), institutional changes (Fortin and Lemieux 1997), the increasingly tournament character of labour markets (Frank and Cook 1995) and the collapse of social norms (Atkinson 1997).

However, all trade based explanation should not be dismissed because there are problems with the simple Stolper-Samuelson version. An alternative trade based explanation working through changes in labour rents based can deal with the problem of explaining wage and unemployment changes together, and is consistent with the lack of change in the factor intensity of production. Despite mounting empirical evidence that such labour rents are large (most recently

Blanchflower, Oswald and Sanfrey 1996) the link between trade and labour rents has not been fully explored[3].

2 Main Features of the Model

The model is of an open economy with two traded goods sectors, facing given world prices. A single period will considered[4]. The primary sector produces a good using labour X and capital K according to a concave and linearly homogenous production function F(X,K) while the secondary sector good uses labour x and capital k according to the concave and linearly homogenous function f(x,k). For simplicity the two sectors will be represented by single profit maximising firms, and the firms may make positive profits. The interaction of firms in product markets is not central to the argument, and no further restrictive assumptions will be made.

The labour market interactions, though are crucial. There will be assumed to be an economy wide wage floor set at a level R, which captures the effect of minimum wage laws, the social welfare payments and so forth. It is assumed that a part of the endowment of N workers are unemployed, denoted U, and so new workers are available to both primary and secondary sector firms at a wage of R.

All labour employed in the primary and secondary sectors is identical, thus abstracting from issues of generalised skill coming from national education and training systems or human capital investments by workers; issues which have been considered by other researchers. The crucial feature of the model is the existence of hiring and firing costs in the primary sector which give incumbent primary sector workers some market power, allowing them to force their wage W

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3 There are two papers which examine links between trade and labour rents, but in different ways to the present paper. Borjas and Ramey (1994) present empirical evidence of a link between the trade deficit in durable goods and inequality, arguing that increasing foreign competition in durable goods depressed the previously high rents earned by unskilled workers employed in durable goods industries, and that this has significantly increased overall wage dispersion. The explanation in terms of labour rents offered in the present paper is somewhat different. Bhagwati and Dehejia (1997) present a model where increasing foreign competition in autos and steel can depress rents obtained by unskilled union members in these industries, where the effects depend on the extent to which the increase in foreign competition is foreseen, and the behaviour of the union.

4 The ideal would be to construct a dynamic general equilibrium, with a stochastic price process along the lines of Bentolila and Bertola (1990) or Bertola (1990). However these existing models are partial equilibrium with a fixed wage, and departing from these assumptions in a dynamic stochastic setting has thus far proved intractable. In a recent survey of dynamic labour demand models Hamermesh and Pfann (1996 p1270) comment that a departure from the assumption of given product and factor prices leads to "substantial complications", and thus far no papers have managed to endogenise the wage. In the PhD thesis chapter on which this paper is based there is further discussion of dynamic issues, but little can be added to the argument of the present paper through the fully dynamic stochastic specification.

above the value of their marginal product[5]. Firing one of the X_0 incumbent primary sector workers costs a constant amount f while hiring an additional primary sector worker costs h, both in discounted present value terms. Voluntary quits and retirements are not considered in the model. Costs of firing include the firing procedure itself, as well as any termination payments or litigation, while hiring costs include advertising and selection, outlays on firm specific training, and lost output while a new worker learns about the firms operations. It is the large training element of the adjustment costs and the empirical association between skill and adjustment costs which will support the identification of primary sector workers as skilled workers later in the paper[6].

Capital, with endowment denoted V, is fully employed and receives a return r. For convenience this other factor of production is referred to as capital but may be any intersectorally mobile factor not subject to hiring and firing costs and for which the reservation wage does not bind.

3 Employment and Wage Setting in the Primary Sector

The most important feature of the model, the behaviour of primary sector firms and incumbent workers, will now be examined in detail. Their interaction is in two stages; first the wage is negotiated by the firm and workers, and secondly the firm chooses employment to maximise profit, given the wage negotiated at the first stage. As is the case with all such problems, they are solved backwards, initially considering the firm's profit maximising employment choice for a given level of wages and then considering wage negotiations in the light of the parties knowledge of the responses of employment to wages[7].

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[5] The potential for incumbent workers to extract rents from hiring and firing costs was pointed out Lindbeck and Snower (1988), who used it to explain hysteresis in unemployment, a variety of other macroeconomic phenomena. The specification of the primary sector wage/employment bargaining in this paper is based on their work.

[6] There has been a limited amount of empirical work on the size and form of hiring and firing costs, beginning with Oi (1962), and summarised by Nickell (1986) and Hamermesh and Pfann (1996). The evidence suggests they are large, vary greatly between industries, and are higher for skilled workers. The form is contentious, but the linear form adopted for this paper has stronger empirical support than the quadratic form often used in the dynamic labour demand literature.

[7] This two stage process is the same as the monopoly union process in the labour economics literature. The trade union bargaining models embodying this monopoly union process are open to the criticism that the outcome is Pareto dominated by an the outcome of an alternative process where the firm and unions bargain jointly over employment and wages. This criticism has less force for the present model because the bargaining is between the firm and individual worker, and employment of an individual is less divisible, and thus less easy to bargain over, than employment of a large number of union members.

The competitively determined rental price of capital cannot be influenced by firms or workers and will be taken as given throughout the discussion of primary sector employment and wage setting in this section. It will of course be determined in the full general equilibrium model of the economy described in the next section.

The primary sector firm's profit maximisation problem for a given goods price p, wage W, rental price of capital r, and incumbent workforce X_o is:

$$(1)\quad \underset{X,\,K}{\text{Max}}\ \pi = p\,F(X, K) - W\,X_0 - R[X - X_0] - K\,r \begin{cases} - h\,[X - X_0] & \text{if } X > X_0 \\ - f\,[X_0 - X] & \text{if } X < X_0 \end{cases}$$

This is a problem of choosing employment X and capital usage K to maximise profit, which is the value of output p F(X, K), less incumbent wages W X_o, less wages of additional workers hired at R, less capital payments K r, less the bracketed costs of hiring and firing which are the unit costs h and f, multiplied by number of workers hired or fired. Conditions for a maximum are:

$$(2)\quad p\,F_X(X, K) - R \begin{cases} - h & \text{if } X > X_0 \\ + f & \text{if } X < X_0 \end{cases} = 0$$

$$(3)\quad p\,F_K(X, K) - r = 0$$

These will form part of the equilibrium conditions of the full general equilibrium model in the next section, but are needed for bargaining over wages, which will now be considered.

It is assumed that workers act individually to maximise their expected wage, knowing that the firm will choose employment to maximise profits[8]. Each worker is identical and knows the parameters of the problem, is of negligible size and negotiates one at a time in a random order with the firm. Under these assumptions there is no interdependence between the individual workers actions, so we can consider how a representative worker negotiates with the firm.

How will a representative worker seeking to maximise their expected wage behave at the wage bargaining table? If the worker sets a wage above the level where the firm fires, They can expect to be fired because they are the worker with whom the firm is currently negotiating. The

[8] In contrast to many union bargaining models, there is no need for an arbitrary assumption of union monopoly power in the labour market. In the hiring and firing cost model any market power that workers posses is explained within a rational individual agent framework.

firm can credibly make this threat because costs of firing are the same regardless of the particular worker fired. For the representative worker, then, maximising their expected wage is equivalent to setting their wage as high as possible without inducing the firm to fire a worker.

How high can the wage be pushed? This depends on the firm's employment responses, which translate into a set of constraints on wage setting:

Any worker always has the option of the reservation wage, so will never set it below this:

(4) $W \geq R$

A worker must ensure that it is profitable for the firm to continue to employ them, and this will be so if the wage is not set above the value of marginal product plus firing costs. This is the retention constraint on wage setting and requires:

(5) $W \leq p F_X(X,K) + f$

A worker must also ensure it is not in the firms interest to replace them with an unemployed worker, so the wage cannot be set above the reservation wage plus the sum of hiring and firing costs. This is the hiring constraint and requires:

(6) $W \leq R + f + h.$

Whichever of the above constraints (4)-(6) binds determines how high the wage can be pushed and defines the potential rents[9]. The other issue is how much of these rents the worker can extract, and in this paper it will be assumed that incumbent primary sector workers are able to capture all the potential rents associated with the hiring and firing costs. If they are only able to extract part of the rents then the nature of the results will not change, and an additional parameter representing the division between firms and workers could be introduced.

Most economists intuition is that the individual worker is at a distinct disadvantage in bargaining and will only gain a small proportion of any rents from the employment relationship. This need

[9] The worker might also be concerned about being replaced by a unit of capital, and must ensure that $W \leq r\ p F_X(X,K)/\ p F_K(X,K) + f$ so that it is not in the firms interest to replace a worker with a unit of capital. In equilibrium, however $r = p F_K(X,K)$ and this capital replacement constraint reduces to the retention constraint, and so is redundant. Another concern the worker might have is that their wage demands could bankrupt the firm, but because each worker is of negligible size and bargains individually with the firm, they have no incentive to moderate their wage demands in the absence of a mechanism to coordinate the wage demands. A bankruptcy

not be so, and an argument can be constructed that the worker will in fact capture all the rents. This argument builds on the non-cooperative bargaining analysis of Rubinstein (1982), who considered two parties with infinite time horizons making alternating offers about the division of a cake of fixed size until an offer is accepted. Rubinstein (1982 p107 Conclusion 1) proved that if there are fixed per period bargaining costs there is a unique subgame perfect Nash equilibrium where the party with the lower per period costs gets all the cake[10]. This suggests that all the rents would go to whichever of the firm and the worker has lower per period bargaining costs. A plausible, while not compelling case can be made that the worker has lower costs, because of the high costs to the firm of administering wage negotiations, of lost production and adverse effects on morale when bargaining is prolonged. Incumbent workers also have the ability to temporarily and partially withhold work effort and adversely impact production during negotiations without the firm having adequate counter strategies short of the costly one of sacking them. In contrast to these potentially large costs for the firms, bargaining imposes few costs on incumbent workers. They keep drawing their wage while negotiations are going on, and negotiations are typically during work time. Many issues, like liquidity constraints because of the lack of a wage during negotiations, which put unemployed workers at a disadvantage negotiating with firms in a weak position, do not apply to incumbent workers. We are talking about renegotiation of the employment contracts of incumbent workers, not the situation of an unemployed worker in a spot labour market, which is behind the perhaps unreliable intuition that workers have little bargaining power. If this argument based on Rubinstein' analysis non-cooperative bargaining theory is considered too extreme, then as noted above, all the results of the present paper continue to hold so long as primary sector workers extract some positive proportion of the rents.

4 Equilibrium in the Model

Now that the employment and wage setting process in the primary sector has been described, the secondary sector and capital market can be added to give a full general equilibrium model.

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constraint will not be included in the model.

[10] The result is quite stark, and the intuition behind it is that all the subgames have the same structure so there is a cost but no strategic advantage to delaying agreement. The party with the higher per period costs has no better alternative, if they move first, than offering all the cake to the other party. If the player with the higher bargaining costs moves first they will actually offer slightly less than all the cake, i.e. all the cake less the per period bargaining costs If they do not move first then they have no better alternative than accepting an offer of none of the cake from the other party It must be said that this result is very special, and some other closely related noncooperative bargaining analyses do not give such stark results. For instance, in the other case analysed by Rubinstein (1982) where bargaining costs are specified as time discount rates for the players the equilibrium

In the secondary sector the wage is set at the level of the reservation wage and employment is determined in the standard manner. The capital market is entirely standard. Like many other general equilibrium trade models, outputs, employment and factor prices are determined solely by production conditions, without reference to demand. The secondary sector good is the numeraire with price 1. Equilibrium conditions of the model are:

The optimal employment condition for primary sector labour, from the firm problem:

(7) $p F_X(X, K) - R \quad \{ - h \text{ if } X>X_0 \} \{ + f \text{ if } X< X_0 \} = 0$

The optimal employment condition for capital in the primary sector, from the firm problem:

(8) $p F_K(X, K) - r = 0$

The optimal employment condition for secondary sector labour:

(9) $f_x(x,k) - R = 0$

The optimal employment condition for capital in the secondary sector:

(10) $f_k(x,k) - r = 0$

The constraints on skilled wage setting, as previously described, one of which will bind:

(11^{I}) $W = R$ or (11^{II}) $W = p F_X(X, K) + f$ or (11^{III}) $W = R + f + h$

The full employment of capital condition:

(12) $0 = V - K - k$

Unemployment of labour:

(13) $U = N - X - x$

These seven equilibrium conditions determine the values of the seven endogenous variables X x W K k r U, given values of the exogenous variables p N X_0 V R h f.

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payoffs are decreasing in the impatience of the player, without going entirely to the more patient player.

There are three types of equilibrium illustrated in figures 1 and 2, depending on which parts of the constraint on primary sector wage setting (condition 11), and the primary sector employment (condition 7) bind, which depend on the price of the primary sector product for given values of the other exogenous variables. In the left hand part of figures 1 and 2 the price of the primary sector product is so low that firms are firing ($X<X_0$ to satisfy $pF_x(X,K)= R-f$ in condition 7) and wages are driven down to the reservation wage ($W=R$ in condition 11^I). At higher levels of p, in the middle portion of the figures, primary sector firms are retaining their incumbent workforce ($X=X_0$ in condition 7) so that and the wage is set by the retention constraint ($W = p F_X(X_0, K) + f$ in condition 11^{II}). At still higher levels of p the primary sector firms hire ($X>X_0$ to satisfy $pF_x(X,K)= R+h$ in condition 7) and the wage is set by the hiring constraint ($W = R+ h+f$ in condition 11^{III}).

Figure 1- Primary Sector Wage Schedule

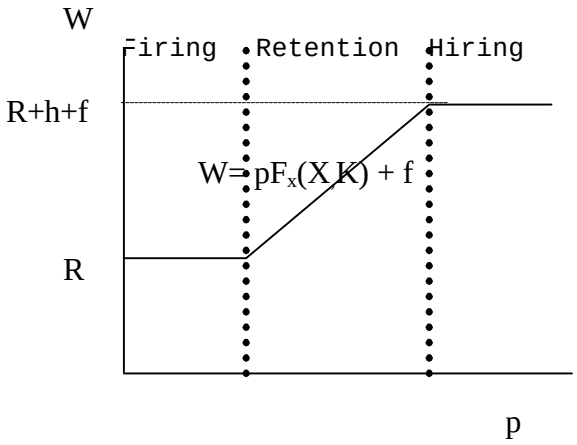
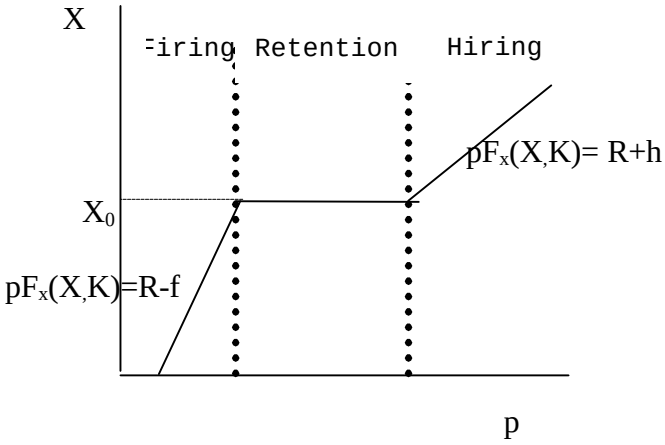


Figure 2- Primary Sector Employment Schedule



The critical values of p that induce hiring and firing in figures 1 and 2 are determined by solving the wage constraint equations (11) or the employment conditions (7) simultaneously, and are $p = (R-f) / F_X(X, K)$ for firing and $p = (R+h) / F_X(X, K)$ for hiring. Thus the size of the band through which prices can fluctuate without inducing primary sector hiring and firing is $(h+f) / F_X(X, K)$, which is increasing in the adjustment costs, and decreasing in the marginal product of labour.

When the hiring and firing occurs the boundaries move[11]. For instance, on hiring, the wage and employment schedules in figures 1 and 2 will shift to the right to become the dotted schedules illustrated in figures 3 and 4.

Figure 3- Effect of Hiring on Wage Schedule

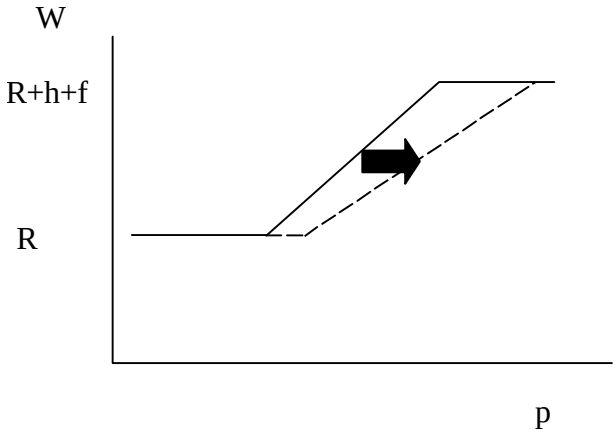
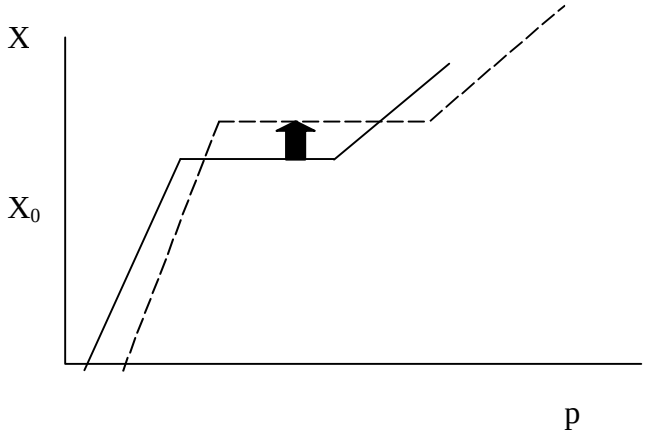


Figure 4- Effect of Hiring on Employment Schedule

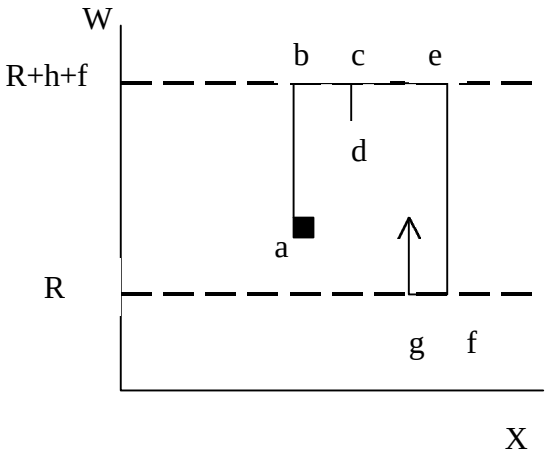


The dynamics are best understood by looking at the paths of primary sector wages and employment as prices change, taking into account any shifts in the boundaries. These paths are illustrated in figure 5. Let's say the primary sector begins at point a within the retention region. As prices improve it will move towards b, with wages increasing at $\partial W/\partial p = F_X(X,K)$ and no change in employment. Eventually if prices continue to improve hiring will be triggered at b and the amount of hiring will ensure condition 7 holds $pF_x(X,K) = R+h$ so that the rate of hiring along the hiring line will be $\partial X/\partial p = -F_X(X,K)/\ pF_{XX}(X,K)$. Now let's say at c that the price shocks start moving in the other direction, against the primary sector. The primary sector will stop hiring and be pushed back into the retention region with falling wages and stagnant employment. At d prices turn around and the hiring line is hit again at c, and hiring continues until e, when the primary sector moves back into the retention region. A long series of negative price shocks then push it all the way back down to the firing boundary at f. Here firing will continue until condition 7 holds so that $pF_x(X,K) = R+h$, and the rate of firing will be $\partial X/\partial p = -F_X(X,K)/\ pF_{XX}(X,K)$. At g a positive price shock pushes it back into the retention region.

[11] More complex dynamic issues arise in a setting with a stochastic price process, as in Bentolila and Bertola (1990) and Bertola (1990), rather than permanent price shocks considered in this paper. As was discussed in an earlier footnote the general equilibrium model with an endogenous wage and stochastic prices is intractable. With stochastic prices firms must consider the effect on hiring and firing decisions of the expected future hiring and

Primary sector wages and employment will continue their path around figure 5 in response to price shocks .

Figure 5 – Paths of Wages and Employment



hiring line $\partial X/\partial p = -F_X(X,K)/\ pF_{XX}(X,K) > 0$
$\partial W/\partial p = 0$

retention region $\partial W/\partial p = F_X(X,K) > 0$
$\partial X/\partial p = 0$

firing line $\partial X/\partial p = -F_X(X,K)/\ pF_{XX}(X,K) > 0$
$\partial W/\partial p = 0$

Now that the possible equilibria and dynamics have been described, we will now move on to the explanation of the recent changes in the wage distribution and unemployment in the light of the model.

5 Explaining Changes in the Wage Distribution

The major fact to be explained is increased wage dispersion[12]. If it is accepted, based on the evidence cited in the introduction, that the world prices of unskilled labour intensive manufactured products have declined, then this represents a decline in the relative price of the secondary sector product in the model[13]. A decline in the relative price of the secondary sector product is the same thing as an increase in the price of the primary sector product, so what we are interested in is the comparative static effects of an increase in p.

If the increase in p keeps primary sector firms within the band where the incumbent workforce is retained, then there is no change in primary sector employment[14]. The value of marginal

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firing costs, and expected future rents earned by incumbent workers.

[12] Algebraic expressions for these and other comparative static results are given in an appendix.

[13] If the economy is able to influence world prices of the goods , then there will be feedback effects on good prices from some of the events considered later in the paper. Considering these reduces the magnitudes of the responses without changing their nature, and the assumption of given world prices simplifies the exposition.

[14] This may be thought to be inconsistent with the empirical evidence of large gross job flows, but recall that for simplicity we are assuming the primary sector is a single firm and ignoring voluntary quits/retirements. Large flows within the primary sector are thus not inconsistent with the model.

product of skilled labour in the primary sector rises, relaxing the marginal profitability constraint and thus increasing the wage W (condition 11^{II}). Capital also moves into the primary sector from the secondary sector (conditions 8 10 12), increasing the marginal product of labour and reinforcing the increase in primary sector wages. Diagrammatically, these effects would be represented by a movement to the right along the upward sloping portion of the wage locus in figure 1, and a movement to the right along the horizontal employment locus in figure 2.

Now since the primary sector wage W has risen and the secondary sector wage is set by the floor R, the change in world prices generates the increase in wage inequality that we have been observing across the OECD. Unlike the Stolper-Samuelson explanation, though, occurs without major reallocations of resources or changes in the proportions of high wage and low wage workers employed. Primary sector employment is not changing as workers push wages up, and we will see in the next section there is a mild contraction in secondary sector employment, which means that the increase in wages of the highly paid is accompanied by an increase in the overall proportion of high wage workers employed across the economy. This sharp contrast with the factor intensity implication of Stolper-Samuelson explanation is due to the mechanism being different – changes in labour rents.

In relation to the particular country experiences of wage inequality, the more pronounced decline in equality in the US can be explained within the model by the additional influence of a decline in the minimum wage there. Fortin and Lemieux (1997 p79) estimate that "the real value of the minimum wage decreased by more than 30% during the 1980s". Other factors like differences in education and training systems are undoubtedly also important.

6 Explaining Changes in Unemployment

The previous section considered the effects on wages, when the primary sector is neither hiring nor firing, of a decline in the relative world price of the secondary sector product. It was that capital moves out of the secondary sector into the primary sector. Now, less capital in the secondary sector means a lower marginal product of unskilled labour, reducing employment in the secondary sector, since the wage remains fixed at R (condition 9). Unemployment must increase because primary sector employment is not changing. Thus there is a channel though which increasing competition in low skill intensive products in world markets can increase in OECD unemployment. This type of firing of workers from low skill intensive manufacturing as capital moves out of these industries seems consistent with recent experience.

There is another channel of effect in the model, though, which is likely to be significant. Consider the effects of balanced flows in and out of the labour force in the model. If the world price change does not shift the primary sector out of the band where they are neither hiring nor firing, then the primary sector will not absorb the new members of the labour force, for even though conditions are improving the benefits are flowing to the incumbent workers in the form of higher rents. Now consider the effect of a reduction in the labour force through the retirement of an incumbent primary sector worker. This will increase the marginal product of the remaining incumbent workers, increasing the rents they can extract, and will not lead the firm to hire a replacement. An addition to the labour force balanced by a primary sector retirement will thus increase unemployment even though the size of the labour force has not changed. Such labour force flows will continue to feed unemployment until the retirements are cumulatively sufficient to shift the economy into the region where the primary sector hires, and this failure to create jobs in sectors which have not been threatened by competition from low skill intensive imports is consistent with recent OECD experience.

Turning to the individual country experiences sharpens the explanation. Earlier in the paper it was shown that the width of the through which prices can fluctuate without inducing primary sector hiring and firing is $(h+f)/ F_X (X_0, K)$, which is larger the greater are hiring and firing costs. Europe, with more regulation of the employment relationship and higher hiring and firing costs will have a wider band. This means that if the US and Europe face the same random world price shocks over the period the US will be more often bumped into the region where primary sector firms hire, and so we would expect the primary sector job creation record of the US to be better over the period. This is what we have observed.

Another difference between parts of the OECD, besides levels of hiring and firing costs, is the level of the reservation wage. Earlier it was shown that the threshold price for primary sector hiring was $p = (R+h) / F_X (X, K)$, which is increasing in R. So countries like the US with a lower reservation wage will be more readily shifted into the region where the primary sector hires as a result of the trend improvement over the period in the relative price of primary sector output.

Another country specific factor relevant to unemployment outcomes is the decline in the reservation wage floor over the period in the US, which the model predicts would allow the secondary sector in the US to soak up workers from the unemployment pool.

7 Conclusions

The model outlined in this paper be used to explain both increasing wage dispersion and increasing unemployment across the OECD over the last two decades as a response to declining relative world prices of unskilled labour intensive products. The increasing wage dispersion comes from the ability of primary sector workers protected by hiring and firing costs to extract greater rents as a result of the change in relative prices. The unemployment increase comes from the movement of capital out of the secondary sector where the wage floor binds, together with the rent extraction related failure of the primary sector to create jobs for new labour force. Particular aspects of the individual country experiences were also able to be explained using the model.

Although the model is built around hiring and firing costs, it must be emphasised that the wage and unemployment trends are not the result of changes in hiring and firing costs. Rather, they are the result of changes in world traded goods prices and other changes in the presence of hiring and firing costs. As such it is a richer trade based explanation than the existing Stolper-Samuelson explanation.

What are the magnitudes of the effects? As was noted in the introduction, a series of studies including Katz and Summers (1989) and Blanchflower, Oswald and Sanfrey (1996) have shown that labour rents are large. There is also evidence that they are growing in industries where they are high already. There is thus the potential for the effects identified in the present paper to be large. However it is far more difficult to show that these rents are due to the existence of hiring and firing costs, as in the present paper, rather than a number of efficiency wage effects, or something else. Separating these competing explanations would far more detailed and reliable data on than is currently available on the variables in the competing micro theories of labour rents. At the moment the data on the levels of hiring and firing costs (particularly firm specific training which seems the largest component) and variations of across industries is inadequate to support formal econometric testing of the model in this paper for one country, let alone across the OECD. Assembling such a data set and formally testing the model is a large project for the future.

What might be the implications for policy if the effects identified are important? It might be thought, for instance, that a tariff to raise the relative price of the secondary sector product is justified to protect the jobs of secondary sector workers and improve the job prospects of the

unemployed. While this is a response, it is not the only response, and is not the optimal response. A better response would be to attack the source of the problem, which is the ability of the primary sector workers to extract the rents at the expense of the job prospects of others. To the extent that policy can influence hiring and firing costs, attacking these will mean that hiring is triggered more easily in the primary sector in response to other shocks. Note however that the empirical studies have shown that the largest component of hiring costs is firm specific training and this is outside the control of policy makers, although it could be subsidised to neutralise the cost to firms. To the extent that the wage floor can be driven down through policy this will also help employment, not just in the secondary sector as in the current minimum wage debate, but also in the primary sector. Of course, before cutting the wage floor the magnitudes of the employment gains and the distributional consequences would have to be carefully considered. A better policy response might be a firm specific training subsidy or a primary sector hiring subsidy financed by taxes on primary sector labour rents.

It must be emphasised that the explanations of the changes in the wage distribution and unemployment identified in this paper, while novel, are not the whole story. They should be viewed in conjunction with other explanations like skill biased technological change and failures of generalised training and human capital acquisition. The model has been presented to emphasise the novel elements, but these alternative explanations could be incorporated by relaxing the assumptions, for instance, that technology is constant and that all workers are identical apart from the rent extraction opportunities that flow from hiring and firing costs in particular industries. The costs of this relaxation, is of course greater complexity. It must also be recognised that the trade and some of the alternative explanations are linked –unskilled labour saving technical change and human capital acquisition can be a responses to foreign competition in low skill intensive products, and the state of technology and human capital themselves influence world commodity prices and trade.

At this stage of the debate over wage inequality and unemployment, there is a need for a comprehensive model that encompasses the major competing explanations and assess the relative contributions of each. So far empirical evidence has been provided in favour of, and against particular explanations. The model of this paper has been shown to be consistent with some major stylised facts about wage dispersion unemployment and wage dispersion, but more formal econometric testing is not feasible due to the lack of data about the size and structure

of hiring and firing costs, and the difficulty of measuring labour rents. Similar data and measurement problems apply to the skill biased technological change and human capital explanations, although they are not as severe and have received more attention from econometricians. At a theoretical level the model of Davis (1998b) which allows consideration of technology and trade together is a way forward, and the computable general equilibrium framework of McDougall and Tyers (1997) and Tyers and Duncan (1997) can add some quantitative flesh to something like the Davis model. With better data and a comprehensive model we would be in a better position to resolve the vital issue of the causes of these adverse developments across the OECD.

Appendix – Comparative Static Algebra

This appendix gives algebraic expressions for the comparative static results in the paper. Expressions are derived for the impact of small changes in the exogenous variables on the endogenous variables in the neighbourhood of the equilibrium. These expressions will then be signed, making use of the properties of the production function f(x,k) that $f_x \geq 0$, $f_k \geq 0$ that $f_{xx} \leq 0$, $f_{kk} \leq 0$, $f_{xk} = f_{kx} \geq 0$ with the same properties for F(X,K). It will be assumed that $\partial x/\partial R \leq 0$, which imposes additional restrictions on the technology which rules out some perverse effects. The secondary sector good is the numeraire with price 1

When Primary Sector Firms are neither Hiring nor Firing

If (7) $X=X_0$ the model can be solved as follows. From (10) $r = f_k(x,k)$. Substitute this into (8) to yield (Δ) $p F_K(X_0, K) - f_k(x,k) = 0$. Substitute (12) $k = V-K$ into (Δ) to yield (α) $p F_K(X_0, K) - f_k(x,V-K) = 0$, and ($\Delta$) into (9) to yield ($\beta$) $f_x(x,V-K) - R = 0$. Now (α) and (β) can be solved for x and K. Once the solutions x and K are known the remaining variables W r Y U can be obtained by substituting these solutions back into the relevant expressions.

From (β) $f_x(x-K) - R = 0$, conditional on a value of K, the following can be obtained using the implicit function theorem:

$\partial x/\partial R = 1/ f_{xx} \leq 0$, conditional on a value of K.

$\partial x/\partial V = - f_{xk} / f_{xx} \geq 0$, conditional on a value of K.

$\partial x/\partial K = f_{xk} / f_{xx} \leq 0$, conditional on a value of K.

From (α) $p F_K(X_0, K) - f_k(x(R,V,K) ,V-K) = 0$ using the implicit function theorem:

$\partial K/\partial p = - F_K / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0$[15].

$\partial K/\partial X_0 = p F_{KX} / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0$.

$\partial K/\partial V = [f_{xk} \partial x/\partial V + f_{kk}] / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] = ?$.

$\partial K/\partial R = f_{xk} \partial x/\partial R / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0$.

From (β) $f_x(x, V- K(p,X_0,V,R)) - R = 0$, using the above expressions for changes in K, the following can be obtained using the implicit function theorem:

$\partial x/\partial p = f_{xk} \partial K/\partial p / f_{xx} \leq 0$.

$\partial x/\partial X_o = f_{xk} \partial K/\partial X_0 / f_{xx} \leq 0$.

$\partial x/\partial V = [- f_{xk} + f_{xk} \partial K/\partial V] / f_{xx} = ?$.

$\partial x/\partial R = [f_{xk} \partial K/\partial R + 1] / f_{xx} \leq 0$.

From (11^{II}) $W = p F_X(X_0, K(p,X_0,V,R)) + f$

$\partial W/\partial p = F_X + p F_{XK} \partial K/\partial p \geq 0$.

$\partial W/\partial X_0 = p F_{XX} + p F_{XK} \partial K/\partial X_0 = ?$.

$\partial W/\partial V = p F_{XK} \partial K/\partial V = ?$.

$\partial W/\partial R = p F_{XK} \partial K/\partial R \geq 0$.

$\partial W/\partial f = 1$.

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[15] This has been signed using the assumption that $\partial x/\partial R \leq 0$. For comparative static expression derived for $\partial x/\partial R$ to be ≤ 0, $\partial K/\partial R$ in the numerator must be ≥ 0. This implies that the denominator of $\partial K/\partial R$ must be ≤ 0, and that the identical numerators of $\partial K/\partial p$, $\partial K/\partial M$ and $\partial K/\partial V$ must also be ≤ 0.

Effects on the rental price of capital can be obtained from (8) $r = p F_K(X_0, K(p,X_0,V,R))$
$\partial r/\partial p = p F_{KK} \partial K/\partial p + F_K = ?$
$\partial r/\partial X_0 = p F_{KX} + p F_{KK} \partial K/\partial X_0 = ?$
$\partial r/\partial V = p F_{KK} \partial K/\partial V = ?.$
$\partial r/\partial R = p F_{KK} \partial K/\partial R \leq 0.$

From (12) $k = V - K(p,X_0,V,R)$
$\partial k/\partial p = - \partial K/\partial p \leq 0.$
$\partial k/\partial X_0 = - \partial K/\partial X_0 \leq 0.$
$\partial k/\partial V = 1 - \partial K/\partial V = ?.$
$\partial k/\partial R = - \partial K/\partial R \leq 0.$

Effects on outputs can be obtained from the production functions $y= f(x(p,_0,V,R), k(p,_0,V,R))$ and
$Y= F(_0, K(p,_0,V,R))$:
$\partial y/\partial p = f_x \partial x/\partial p + f_k \partial k/\partial p \leq 0.$
$\partial y/\partial X_0 = f_x \partial x/\partial X_0 + f_k \partial k/\partial X_0 \leq 0.$
$\partial y/\partial V = f_x \partial x/\partial V + f_k \partial k/\partial V = ?.$
$\partial y/\partial R = f_x \partial x/\partial R + f_k \partial k/\partial R \leq 0.$
$\partial Y/\partial p = F_K \partial K/\partial p \geq 0.$
$\partial Y/\partial X_0 = F_X + F_K \partial K/\partial X_0 \geq 0.$
$\partial Y/\partial V = F_K \partial K/\partial V = ?.$
$\partial Y/\partial R = F_K \partial K/\partial R \geq 0.$

Effects on unemployment can be obtained from (13) $U = N - X_0 - x(p,X_0,V,R)$:
$\partial U/\partial p = - \partial x/\partial p \geq 0.$
$\partial U/\partial X_0 = -1 - \partial x/\partial X_0 = ?.$
$\partial U/\partial V = - \partial x/\partial V = ?.$
$\partial U/\partial R = - \partial x/\partial R \geq 0$

When Primary Sector Firms are Hiring
When hiring $X>X_0$ and $W=R+h+f$, the model is solved in a similar way. From (10) $r = f_k(x,k)$. Substitute (10) into (8) to yield (Δ) $p F_K(X, K) - f_k(x,k) = 0$. Substitute (12) $k = V-K$ into (Δ) to yield (α) $p F_K(X, K) - f_k(x,V-K) = 0$, and (Δ) into (9) to yield (β) $f_x(x,V-K) - R = 0$. So far this is exactly the same procedure as previously. When hiring (7) $p F_X(X, K) -h -R = 0$ is needed as well as (α) and (β) to obtain X, x and K. Again, once the solutions X x and K are known the remaining variables r y Y and U can be obtained by substituting these solutions back into the relevant expressions.

From (β) $f_x(x,V-K) - R = 0$, conditional on a value of K, the following can be obtained using the implicit function theorem:
$\partial x/\partial R = 1/ f_{xx} \leq 0$, conditional on a value of K.
$\partial x/\partial V = - f_{xk} / f_{xx} \geq 0$, conditional on a value of K.
$\partial x/\partial K = f_{xk} / f_{xx} \leq 0$, conditional on a value of K.

From (α) $p F_K(X, K) - f_k(x(R,V,K) ,V-K) = 0$, conditional on a value of X, the following can be obtained using the implicit function theorem:
$\partial K/\partial p = - F_K / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0$, conditional on a value of X[16].

[16] This and many of the subsequent results are signed using the assumption that $\partial x/\partial R \leq 0$, by a similar argument to that used for the retention equilibrium.

$\partial K/\partial X = - p F_{KX} / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0$, conditional on a value of X.
$\partial K/\partial V = [f_{xk} \partial x/\partial V + f_{kk}] / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] = ?$, conditional on a value of X.
$\partial K/\partial R = f_{xk} \partial x/\partial R / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0$, conditional on a value of X.

From (7) $p F_X (X, K(p,X,V,R)) - h - R = 0$, using the implicit function theorem:
$\partial X/\partial p = [- F_X - p F_{XK} \partial K/\partial p] / [p F_{XX} + F_{XK} \partial K/\partial X] \geq 0.$
$\partial X/\partial V = [- p F_{XK} \partial K/\partial V] / [p F_{XX} + F_{XK} \partial K/\partial X] = ?.$
$\partial X/\partial R = [- p F_{XK} \partial K/\partial R + 1] / [p F_{XX} + F_{XK} \partial K/\partial X] = ?.$
$\partial X/\partial h = [1] / [p F_{XX} + F_{XK} \partial K/\partial X] \leq 0.$

From (α) $p F_K (X(p,V,R,h), K) - f_k (x(R,V,K) ,V-K) = 0$, using the implicit function theorem:
$\partial K/\partial p = [- F_K - p F_{KX} \partial X/\partial p] / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0.$
$\partial K/\partial V = [- p F_{KX} \partial X/\partial V + f_{xk} \partial x/\partial V + f_{kk}] / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] = ?.$
$\partial K/\partial R = [- p F_{KX} \partial X/\partial R + f_{xk} \partial x/\partial R] / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \geq 0.$
$\partial K/\partial h = [- p F_{KX} \partial X/\partial h] / [p F_{KK} - f_{xk} \partial x/\partial K + f_{kk}] \leq 0.$

From (β) $f_x (x,V-K(p,V, R, X(p,V,R,h))) - R = 0$, using the implicit function theorem:
$\partial x/\partial R = [f_{xk} \partial K/\partial R + f_{xk} \partial K/\partial X \partial X/\partial R + 1] / f_{xx} \leq 0.$
$\partial x/\partial V = [- f_{xk} + f_{xk} \partial K/\partial V + f_{xk} \partial K/\partial X \partial X/\partial V] / f_{xx} = ?$
$\partial x/\partial p = [f_{xk} \partial K/\partial p + f_{xk} \partial K/\partial X \partial X/\partial p] / f_{xx} \leq 0.$
$\partial x/\partial h = [f_{xk} \partial K/\partial X \partial X/\partial h] / f_{xx} \geq 0.$

Effects on the price of capital can be obtained from (8) $r = p F_K (X(p,V,R,h), K(p,V,R,h))$
$\partial r/\partial p = p F_{KX} \partial X/\partial p + p F_{KK} \partial K/\partial p + F_K = ?.$
$\partial r/\partial V = p F_{KX} \partial X/\partial V + p F_{KK} \partial K/\partial V = ?.$
$\partial r/\partial R = p F_{KX} \partial X/\partial R + p F_{KK} \partial K/\partial R = ?.$
$\partial r/\partial h = p F_{KX} \partial X/\partial h + p F_{KK} \partial K/\partial h = ?.$

From (12) $k = V - K(p,V,R,h)$
$\partial k/\partial p = - \partial K/\partial p \leq 0.$
$\partial k/\partial V = 1 - \partial K/\partial V = ?.$
$\partial k/\partial R = - \partial K/\partial R \leq 0.$
$\partial k/\partial h = - \partial K/\partial h \geq 0.$

Effects on outputs can be obtained from the production functions $y= f (x(p,V,R,h), k(p,V,R,h))$ and
$Y= F (X(p,V,R,h), K(p,V,R,h))$:
$\partial y/\partial p = f_x \partial x/\partial p + f_k \partial k/\partial p \leq 0.$
$\partial y/\partial V = f_x \partial x/\partial V + f_k \partial k/\partial V = ?.$
$\partial y/\partial R = f_x \partial x/\partial R + f_k \partial k/\partial R \leq 0.$
$\partial y/\partial h = f_x \partial x/\partial h + f_k \partial k/\partial h \geq 0.$
$\partial Y/\partial p = F_X \partial X/\partial p + F_K \partial K/\partial p \geq 0.$
$\partial Y/\partial V = F_X \partial X/\partial V + F_K \partial K/\partial V = ?.$
$\partial Y/\partial R = F_X \partial X/\partial R + F_K \partial K/\partial R = ?.$
$\partial Y/\partial h = F_X \partial X/\partial h + F_K \partial K/\partial h \leq 0.$

Effects on unemployment can be obtained from (13) $U = N - X(p,V,R,h) - x(p,V,R,h)$:
$\partial U/\partial p = - \partial X/\partial p - \partial x/\partial p = ?.$
$\partial U/\partial V = - \partial X/\partial V - \partial x/\partial V = ?.$
$\partial U/\partial R = - \partial X/\partial R - \partial x/\partial R = ?.$
$\partial U/\partial h = - \partial X/\partial h - \partial x/\partial h = ?.$

When Primary Sector Firms are Firing

When firing equilibrium $X<X_0$ and W=R, the solutions are identical to those when hiring except that (7) becomes $p F_X(X, K) + f - R = 0$ instead of $p F_X(X, K) - h - R = 0$. Hiring costs now do not matter but firing costs do, and the responses to changing firing costs are the reverse of the previous responses to changes in hiring costs.

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