INTERNATIONAL TRADE THEORY UNDER IMPERFECT COMPETITION IN PRODUCT AND LABOUR MARKETS.

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For my parents, brothers and sister.

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ABSTRACT

This thesis concerns the interaction of imperfections in product and labour markets. In the first three chapters we examine the implications of this analysis for the normative side of international trade theory. In *chapter one* we focus on export policy in the old and new school of international trade theory when there is an imperfection in product markets. We outline the product market rent creation motives for intervention in the different schools. In chapters two and three we incorporate labour market imperfections into the analysis of chapter one. We look at the interaction of product and labour market rent creation motives for trade policy in the two schools of trade theory. *Chapter two* deals with unionised intra-industry competition and trade policy (export and domestic). *Chapter three* looks at intra-industry competition, efficiency wage payments and export policy. In *chapter four* we develop the theory of vertical spillovers under imperfect competition in the product and labour market. The theory tracks vertical spillovers from the *upstream* labour market to the *downstream* product market and vice versa. Using U.K. panel data, we find evidence for the presence of these spillovers.

INTRODUCTION

In this thesis we look at the interaction of imperfections in product and labour markets. In the first three chapters we examine the implications of this analysis for the normative side of international trade theory. In the last chapter we develop the theory of vertical spillovers between the product and labour market and find empirical evidence for the presence of these spillovers in U.K. firm level panel data.

In *chapter one* we abstract from having labour market imperfections in our model and focus on export policy in the old and new school of international trade theory. We recast the analyses of both schools and show how they both build an endogenous trade divergence into their analysis. Corden in his book "Trade Policy and Economic Welfare" (1974), defines a trade divergence as a divergence between the social marginal revenue and private marginal revenue of home production. We model a trade divergence in the old school by allowing the government to anticipate intra *home* industry competition over rent in a foreign market and the detrimental effect this can have on home welfare. The home government in anticipation of this, levies a tax on each home firm to ensure that maximum rent is taken home from the foreign market, even in the presence of intra home industry competition. The magnitude of intervention depends *positively* on the intensity of intra home industry competition. Our definition of an endogenous trade divergence (due to intra home industry competition over rent in a foreign market) corresponds to Bhagwati's (1971) *endogenous distortion* and Krishna and Thursby's (1988) *trade distortion.* As Corden points out, the word distortion gives the false impression that the divergence is not endogenous but is a by-product of a exogenous change in our model.

Over the last decade we have seen an proliferation of research in what is

described as the new theory of International economics on export policy. For many, this represents a major breakthrough and calls into question the traditional lessons on export policy. It has be claimed that the motive for intervention in the old school, which originates from the Bickerdike's (1906) terms of trade argument for a tax, is a very different motive for intervention than that of the new school, which originates from the Brander and Spencer's (1985) profit shifting argument. It is argued here that the only difference between the two schools is that the new theory focuses on *international* intra-industry competition and the detrimental effect this has on welfare, while the focus of the old school is on the detrimental effect of intra *home* industry competition on home welfare.

A trade divergence is modelled by in the new school by allowing the home government to anticipate international intra-industry competition over rent in a foreign market and the detrimental effect this can have on home welfare. A subsidy for each home firm is optimal when the home government anticipates *price support* for the home firms. This analysis offers a rationalization of why governments give subsidies to exporting firms that produce agricultural products. A restraint on home firm output becomes optimal when the home government anticipate *price following* by foreign firms to the prices set by the home firms. This analysis explains why governments, in a certain class of manufacturing export industries, voluntarily restrain the exports of home firms when they are guaranteed that foreign firms will follow their prices. In both cases, the magnitude of intervention depends *negatively* on the intensity of international intra-industry competition.

In chapters two and three we incorporate labour market imperfections into the analysis of chapter one. We look at the interaction of the product market rent and labour

rent creation motives for trade policy in the two schools of trade theory. In *chapter two* we examine trade policy in the old and new schools of international trade theory in the presence of unionised intra-industry competition. We incorporate endogenous trade and domestic divergences into the analyses of both schools. The trade divergences are modelled as in chapter one. The domestic divergence results from the government's anticipation of *wage bargaining* over the rent created by home firms and the detrimental effect it has on welfare. The government anticipates that the home firms will not treat the rent component of a wage bill as a social benefit of production. Following Sah and Stiglitz (1985), we include the rent component of the wage bill in social surplus, on the grounds that this constitutes rent generated within the industry. We look at *export* policy in the presence and in the absence of international competition. In general, a subsidy can be optimal in conditions where unionised intra-industry competition is weak and unions are strong. These conditions give the home government an incentive to increase social surplus by pulling labour into home firms that pay high wage premiums. There is a labour rent creation motive for trade policy.

We also look at *domestic* policy in the presence and in the absence of international competition. The optimal subsidy to home firms always brings industry output to the socially optimal Bliss point, even in the presence of international competition. Free trade is only optimal in the limiting case of perfect intra-industry competition. The optimal tariff levied on foreign firms always brings industry output to a level equivalent to that which would be produced by a non-unionised monopoly firm. The optimal tariff appropriates the monopoly rent to the home country in the form of increased home firm rent, labour rent and tax revenue. In welfare terms, the optimal tariff is always a second best domestic policy instrument. However, it leads to a

preferred outcome compared to the outcome that would result in the free trade equilibrium. From the society's point of view, free trade is the third best outcome. It allows foreign firms to exploit consumers and earn rent that is of no value to the home country.

In *chapter three* we examine export policy in the presence of imperfect intra-industry competition and efficiency wage payments. We model trade divergences using intra-industry competition and a domestic divergence using an efficiency wage model. We look at *export* policy in the presence and in the absence of international competition. As in the case of wage bargaining, a subsidy per unit of *output* can be optimal when the home government anticipates conditions where intra-industry competition is weak and wage premiums are high. These conditions give the home government an incentive to increase social surplus by pulling labour into home exporting firms who pay high wage premiums. There is a labour rent creation motive for trade policy.

A subsidy per unit of *labour* to home country exporting firms who pay efficiency wages is shown not to increase social welfare. This distinction between a product market and labour market subsidy did not arise in chapter two. The domestic and trade divergence are directly inter-linked in the presence of wage bargaining. Both a labour or product market policy instrument can be used to internalise the anticipated divergences. Katz and Summers (1989) were the first to examine the optimality of a labour subsidy in the presence of efficiency wage payments. They make a welfare argument that a labour subsidy should be to given to "sunrise" exporting industries as a policy to encourage employment in a high wage premium sector.

Their argument depends upon the ability of workers to extract rents as the demand for labour increases in response to the labour subsidy. This is not the case in

our generalised efficiency wage model. We show that in response to a labour subsidy, the wage premium offered by the firm declines. The optimal labour subsidy has no effect on the output produced by home firms. The same output is produced with more labour and less effort. Product market rent remains unchanged. Labour rent also remains unchanged. Even though home firms are more labour intensive, the wage premium falls and ensures that the rent component of the wage bill is unchanged. This suggests that a labour subsidy that pulls employment into "sunrise" exporting firms does not increase welfare. There is no rent creation (in the product or labour market) motive for a labour subsidy in the presence of efficiency wages.

In *chapter four* we examine the vertical spillovers when we have imperfections in both the product and labour market. Efficiency wage theories in recent years have been put forward as attractive ways of explaining involuntary unemployment and other aspects of the labour market. However the best general evidence for efficiency wage payments thus far is based on a *proof by contradiction* approach. These studies reject the hypothesis that competitive and bargaining theories can explain one hundred percent of the wage differentials that exist in U.S. industry. Indirectly they see this as evidence for the existence of efficiency wage payments.

Solow's (1979) model captures the essence of the efficiency wage argument. The key feature of his model and all efficiency wage models is that the wage has a dual function. One function is to hire labour and the other is to create incentives that reduce efficiency costs. Our key insight is to note that rent sharing under efficiency wage payments is fundamentally a different type of rent sharing than that under wage bargaining. The wage premium that results from an efficiency wage payment is only a fraction of the product market rent it creates. This is a share in *additional rent* created

by the wage premium itself rather than a share in the *absolute rent* created by the firm. A firm does not commit to paying wage premium incentives if there is no net gain in product market performance from doing so.

To find evidence of efficiency wage payments in firms we take a very different route to that taken in the proof by contradiction approach. Our approach is in the same spirit of the more direct tests of efficiency wage theories. Most efficiency wage theories predict a positive relationship between a wage premium incentive and performance. Up to now performance was measured in a very specific way which related to a particular model of efficiency wage theory. Most of this empirical work finds a positive and significant relationship between a specific measure of performance and a wage premium. However, the wage premium never seems *to pay for itself.* Efficiency wage theory would predict that it should only be a fraction of the rent it creates. We believe the decision to be a high wage firm infers many benefits and not just one. The key feature is that the wage premium incentives will lead to better product market performance. Exactly how the wage premium incentives reduce efficiency cost is treated as a *black box.* The net outcome will always be an improvement in product market performance. Our measure of a firm's product market performance is market share. A firm that infers the benefits of being a high wage premium employer will, as a result, do *relatively* better in product market performance as measured by market share.

The theory we develop tracks vertical spillovers from wage determination in an *upstream* labour market to market share determination in a *downstream* product market and vice versa. Specifically, we track vertical spillovers within Sutton's (1991) oligopoly framework under alternative theories of wage determination. Variations in the outside option for workers in an industry are taken not to give one firm an advantage over

another and generates no vertical spillovers between wage determination and market share determination in the downstream product market. A competitive theory of the labour market allows an asymmetric compensating differential (due to idiosyncratic features of firms) to create a downstream vertical spillover that leads to a negative relationship between unit wage cost and market share performance. The theory predicts that efficiency wage payments creates a unique downstream vertical spillover that leads to a positive relationship between unit wage cost and performance in the product market. The presence of wage bargaining is shown to drive a two-way vertical spillover. The downstream spillover due to the presence of wage bargaining leads to a negative relationship between unit wage cost and performance in the product market. Wage bargaining can also lead to a positive relationship between unit wage cost and market share performance. However, it is a spillover that flows in the *opposite direction* to that created by efficiency wages.

We set out to discriminate between the *downstream* spillover due to the presence of wage bargaining and that due to efficiency wage payments. To this end, we use our theory to *constrain the data.* Our basic data source is a panel of 993 UK *large* manufacturing firms. Our theory relates to industries where goods do not have vertical attributes. For this reason, we focus exclusively on relatively homogenous goods industries. We split the data into a high and low unionised sample of firms. This is an attempt to constrain the data to discriminate between the downstream vertical spillovers due to efficiency wage payments and wage bargaining.

The average wage of the low unionised firms over the period 1973-1982 was very much in line with the high unionised sample. However the wage dispersion is greater within the low unionised sample and grows over the period analysed. Over the

period 1973-1982, exploiting the pooled cross sectional and time series dimension of our data set, we find evidence, in the low unionised sample, that firms voluntarily paid high wages to induce better market share performance. We take this as direct evidence that the high wage firms in this sample paid efficiency wages. We also find evidence, in the high unionised sample, that firms involuntarily paid high wages, which had a detrimental effect on their market share performance.

CHAPTER 1

ENDOGENOUS TRADE DIVERGENCES AND EXPORT POLICY

INTRODUCTION

In this chapter we examine export policy following the old and new schools of international trade theory. We recast the analyses of both schools and show how they build an endogenous trade divergence into their analyses[1]. A trade divergence is modelled in the old school by allowing a home government to anticipate that competition between home firms in the same industry over rent in a foreign market can have a detrimental effect on home welfare. The home government, in anticipation of this, can undertake measures that ensure, even in the presence of *intra home industry competition*, that the maximum rent is taken home from the foreign market. A trade divergence is modelled in the new school by allowing the home government to anticipate that competition between home firms *and* foreign firms in the same industry over rent in a foreign market can have a detrimental effect on home welfare[2]. The home government, in anticipation of this, can undertake measures that ensure, even in the presence of *international intra-industry competition*, that the maximum rent is taken from the foreign market.

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[1] A matter of terminology: Corden (1974) in his book "Trade Policy and Economic Welfare" defines a *trade divergence* as a divergence between the social marginal revenue and private marginal revenue of home production. What we call an endogenous trade divergence, due to intra home industry competition over rent in a foreign market, Bhagwati (1971) calls an *endogenous distortion* and Krishna and Thursby (1988) call a *trade distortion.* As Corden (1974) points out, the word distortion gives the false impression that the divergence is not built into the framework in which we work, but is a by-product distortion that could be policy induced.

[2] Some authors have begun to realise that the new theory shares some analytical features with Bickerdike's (1906) orthodox optimal tax argument for trade policy (Deardoff and Stern (1987), Harris (1989) and Corden (1990). Corden (1990) feels that within the new theory " ...the issue on which the orthodox terms of trade argument focuses disappears." The focus was claimed to be on profit shifting rather than on a terms of trade improvement. It is argued here that the key difference between the old and new theory is that a government expects a trade divergence will result due to international intra-industry competition in the new school rather than intra home industry competition, which is the focus of the old school.

In section I the old school analysis is undertaken using two different equilibrium concepts. The first corresponds to the more traditional analysis of export policy: the firms are assumed to operate in a perfectly competitive home exporting industry. The second corresponds to a modern industrial organisation approach: the firms are modelled as operating in an oligopolistic home export industry.

The competitive framework captures, in an extreme way, the idea that competition between home firms can lead to the overall rent earned by home firms in an industry to fall to zero. The home government, in anticipation of this, imposes a tax per unit of output on each firm to ensure that, even in the presence of intra home industry competition, the home country takes the maximum rent in the foreign market in the guise of tax revenue.

Within the modern Industrial Organisation approach a general result emerges from the two-stage games we outline. If the government anticipates any competition by home firms over rent in a foreign market, it will levy a tax per unit of output on each firm to ensure that each home firm produces at the price and output of a home firm under Joint Profit Maximisation. The magnitude of the tax levy and the trade divergence anticipated, depends on the wedge driven between the anticipated price cost margin under free trade and the margin that would result for each firm under Joint Profit Maximisation. This wedge is positively related to the intensity of intra home industry competition. This ensures that the home country extracts the maximum rent from the foreign market. The rent is taken by the home country either in the form of tax revenue or a combination of both firm rent and tax revenue.

In section II the analysis of the new school is undertaken in a series of two-stage games. Initially, we abstract from having intra-industry competition between firms

operating from the same country. We focus on export policy and a trade divergence that results from the government's anticipation of international intra-industry competition over foreign rent. One key element of this analysis is that in anticipation of the detrimental effect that competition between the home firm and the foreign firm will have on home welfare, the home government can only impose a policy instrument on the home firm. The trade divergence is created by giving the home government first mover advantage. Given a first mover advantage, it can exploit its knowledge of the foreign firm's optimal response function. The more profitable the home firm, the more it can exploit this first mover advantage. From the social perspective, the government expects the home firm to calculate incorrectly its loss on inframarginal sales. This is what drives the wedge between the SMR and the PMR in home export production[3].

The sign of the trade divergence depends on how we build the optimal responses of the foreign firm. Its magnitude depends on the profitability of the home firm in the simultaneous move equilibrium. The government anticipates *two* different types of

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[3] Krishna and Thursby (1988) label our trade divergence as a *strategic distortion.* In the same spirit, Helpman and Krugman (1989) in their book "Trade Policy and Market Structure" feel that the Cournot or the Bertrand strategy in themselves create a distortion since the *perceived* private marginal revenue by the firm is not the same as the *true* private marginal revenue curve it faces. They feel that it is the firm that miscalculates the loss on inframarginal sales and creates a distortion. The next insight allows Corden's trade divergence concept to run across both the old and new school on export policy. In a full information simultaneous move Nash equilibrium there is no miscalculation of the loss on inframarginal sales. In equilibrium the firms playing either the Cournot or Bertrand strategy calculate the loss on inframarginal sales correctly. The perceived marginal revenue curve is the actual private marginal revenue curve they face. The miscalculation of the loss on inframarginal sales is only in the *eyes* of the home government. The government is assumed to have first mover advantage and looks at a *different game* compared to the game that the home firm is assumed to be in. The social marginal revenue curve is a curve that the home firm would face if it had first mover advantage. It is the assumption that firms move simultaneously *and* the home government moves first that creates the trade divergence. Neither the Cournot strategy or the Bertrand strategy can in themselves lead to the creation of a trade divergence.

responses by the foreign firm to the actions undertaken by the government. In the first game we model the government as anticipating that in response to giving the home firm a cost advantage, the foreign firm will find it optimal to reduce output and offer *partial price support.* We use Cournot competition to model this sort of response by the foreign firm. The subsidy under Cournot competition is optimal once the partial price support offered by the foreign firm and the home firm's price cost mark-up are significant. The more profitable the home firm, the bigger the subsidy, as the government can exploit the price support to a greater extent.

This result still holds when we allow intra-industry competition between firms that operate from the same country; provided that there is as many foreign firms as home firms in the industry and this increased intra-industry competition does not drive home firm's equilibrium price cost margins to zero. In other words, the price support effect and home firm's price cost margins remain significant. Increasing the number of firms will lead to a smaller optimal subsidy payable to each home firm, but the subsidy still remains optimal. The optimal subsidy is negatively related to the intensity of international intra-industry competition.

The use of Cournot competition in this game can represent any factor that holds the industry price up as the home firms expand their output and also allows each home firm to earn a positive price cost margin. Once a home government anticipates these features in an industry, a subsidy per unit of home output is optimal. This analysis offers a rationalization why governments give subsidies to exporting firms that produce agricultural products.

In the second game, we model the government as anticipating a *price following* response by the foreign firm. We use Bertrand competition to model this type of

response by the foreign firm. A tax under Bertrand competition is optimal as both the partial price following by the foreign firm and the home firm's price cost mark-up are significant. The more profitable the home firm, the bigger the tax, as the government can exploit more the price following offered by the foreign firm.

This result still holds when we allow intra-industry competition between firms that operate from the same country, provided that there is as many foreign firms as home firms in the industry, thus ensuring that the price following effect is significant. The more firms that enter the industry, the lower the equilibrium price cost margin earned by the home firms and the less the government can exploit the price following offered by the foreign firms. Hence, the optimal tax levied on each home firm is negatively related to the intensity of international intra-industry. The use of Bertrand competition in this game can represent any factor that relaxes competition as the home firms contract their output and allows each home firm to earn a high price cost mark-up. Once a home government anticipates this feature in an industry, a tax per unit of home output (or a legal export restraint) will be optimal. The tax (or degree of restraint) will be negatively related to the intensity of competition in an industry. This analysis explains why governments, in a certain class of manufacturing export industries, voluntarily restrain the exports of home firms when they are guaranteed that in response foreign firms will price follow.

Section I: The Old School and Export Policy

The set of players in this section consists of N home firms and a domestic government. The home firms in this analysis are assumed to operate in a foreign market which we call "consumerland". We focus on *export* policy and model a trade divergence that results from the government's anticipation of intra *home* industry competition over rent in consumerland. We abstract from international intra-industry competition until the next section.

The N identical home firms produce a homogeneous product. A home firm produces x and earns a payoff π. The inverse demand curve in consumerland is assumed to be the following:

$$P(Q) = a - Q, \qquad P' < 0 \tag{1}$$

Let $c^{\cdot} = (c - s)$ be the home firm's unit variable cost, net of a subsidy per unit of output. Let fixed costs of production be zero. We write the payoff to the a home firm as:

$$\pi = (P(Q) - c^{\cdot})x \tag{2}$$

The payoff to the home government is the following surplus function:

$$G = N(\pi - sx) \tag{3}$$

The analysis of the home firms and the government will be undertaken using two different equilibrium concepts. The first corresponds to the more traditional analysis of

export policy where the firms are assumed to operate in a perfectly competitive home exporting industry. The second corresponds to a modern industrial organisation approach. We model the firms as operating in an oligopolistic home export industry. The government in the latter case moves first and is assumed to understand the dependence of the second stage on the first when choosing its optimal subsidy level. This will lead to a Nash Equilibrium in each subgame of the more modern game. The traditional analysis corresponds to stage one of the modern analysis where we use a competitive equilibrium to model the payoffs of the home firms.

The Traditional Analysis

In the traditional analysis a home firm is a price taker and chooses x to maximise π, given c^*. We write down the first order condition as the following:

$$\pi_x = P - c^* = 0, \qquad \pi_{xx} < 0 \tag{4}$$

Each home firm is modelled as earning a normal rent. The solution function for x can be obtained from its first order condition and we express it as $x^0(c, s) = (a - c^*)/N$. The industry output that results is $Q^{PC} = (a - c^*)$.

The domestic government chooses to maximise G, in anticipating the nature of competition between the firms. We write down the first order condition as the following:

$$G_s = N(\pi_s - x - sx_s) = 0 \tag{5}$$

From (5), we note that $\pi_s = QP'Nx_s + x$, and we solve for the optimal subsidy as the following:

(6) $$s^o = QP' < 0$$

The government finds it optimal to tax each firm $s^o < 0$ per unit of output. The traditional theoretical expression for (6) is the optimum export tax "rate" $s^o = 1/\varepsilon$, where ε is the elasticity of export demand. The optimal tax on each firm shifts the industry supply curve upwards, inducing a market clearing price that leads each firm to produce 1/Nth of the monopoly output. By substituting s^o in (6) into (4) this is equal to $x^o = (a-c)/2N$ (A monopoly firm would set its output Q^m to maximise $\pi(Q)= (P - c)Q$ and in this example would produce $Q^m = (a-c)/2$). The industry is taxed back to the monopoly output and the monopoly rent is taken home in the guise of tax revenue[5]. This is done to internalise a *trade divergence* that would result in the free trade equilibrium. Each firm takes the industry price as given, when in fact, it depends on industry output. The competitive framework captures, in an extreme way, the idea that competition between home firms in consumerland can cause the overall rent for the firms in the industry to fall to zero. Corden (1974) defines a trade divergence as a divergence between the social marginal revenue and private marginal revenue in home production. In the above model the home government anticipates that the industry will not take home any rent from consumerland. From a social perspective, the government expects a home exporting firm would not take account of the loss in revenue on inframarginal sales QP'. The optimal

[5] In the above model the short run supply curve of the competitive industry is assumed to be perfectly elastic. The tax creates and takes home the monopoly rent at the expense of foreign consumers. When the short run supply curve is upward sloping the tax will also take the monopoly rent home but the burden is shared by the home industry and the consumers. The rent taken from the home industry does not benefit the home country and there is also a loss in industry rent that is not captured by anyone as a result exports forgone. The optimal tax will always capture the monopoly rent in the form of tax revenue, irrespective of the slope of the supply curve.

tax on each firm cuts industry output back to correspond to the output level of a monopoly firm selling into consumerland. This internalises the trade divergence.

(7) $$s^o = QP' = SMR - PMR < 0$$

The motive for intervention is to capture the monopoly rent via taxation in anticipation of the failure of the home industry to do so in the free trade equilibrium. What determines the level of the tax on each firm? A monopoly firm would set its output Q^m to maximise $\pi(Q)= (P - c)Q$. The first order condition for the monopoly firm sets $(P - c)^m = - QP'$. This allows us to re-state the optimal tax as the following:

(8) $$s^o = - (P - c)^m = SMR - PMR < 0$$

The level of optimal tax on each firm is set equal to what would be the price cost margin of a monopoly firm selling into consumerland. The bigger the monopoly mark-up anticipated by the government, the bigger the optimal tax per unit on each firm. The optimal tax on each firm is such as to capture monopoly rent in the guise of tax revenue $t^o x^m = (P - c)^m x^m$. Even in the presence of intra home industry competition, the home country takes home the maximum rent from consumerland.

The Modern Industrial Organisation Analysis

Under oligopoly, game theoretic models allow us to model the home government to anticipate various intensities of competition between the home firms over the rent available in consumerland. We follow an approach taken by Sutton (1991). Sutton employs three simple *building blocks* from the game theoretic oligopoly models to model

a functional relationship between a firm's price cost margin and the level of concentration in the industry. Figure 1:1 summarises the Joint Maximisation, Cournot and Bertrand formulations for a homogenous product. Under oligopoly, a firm's equilibrium price cost margin can be modelled to vary from the monopoly to the competitive level, for a given historically determined level of concentration. As in Sutton (1991), by changing the *toughness of price competition* (by changing the type of strategic competition and the degree of product differentiation) it is possible to generate any price cost margin which lies in between these extremes. Joint Profit Maximisation is a building block to model zero price competition and is motivated by a simple application of a Folk Theorem[6]. Homogeneous Cournot competition is a *building block* to model weak price competition and homogeneous Bertrand competition is a *building block* to model the limit of strong price competition. The interpretation of our results should not be based on these certain class of oligopoly models but on the intensity of price competition and the price cost margins that come from these models. The model of Joint Profit Maximisation is a limiting case where the home government anticipates no competition between home firms over the rent in consumerland: each home firm is

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[6] The Joint Profit Maximisation outcome would not be supported as a non-cooperative (Nash equilibrium) in a static model of Cournot (Bertrand) competition. If we replace the one-shot representation of these games by an infinite-horizon dynamic game in which firms set output (q_i) or price (p_i) and receive payoffs over successive periods, Joint Maximisation can be supported as a noncooperative outcome. Let the constituent game played in each period be the Cournot (Bertrand) game. The following is an elementary application of a Folk Theorem. The strategy for $firm_i$ in the repeated game is a function that maps the outputs (prices) set by the two firms in the periods $1,...,t_{-1}$ into q_i (p_i) for $firm_i$ in period t. $Firm_i$'s payoff is the discounted sum of its profits in each period $\Sigma\delta^t\pi_{it}$. The following (trigger) strategies support the co-operative outcome as a non-cooperative (Nash equilibrium) in the repeated game. $Firm_i$ sets half the monopoly output $1/2q^m$ (monopoly price p^m) if and only if no output (price) in any earlier period is greater than $1/2q^m$ (less than p^m). Otherwise $firm_i$ produces at the Cournot (Bertrand) output (price) level.

expected to take home an equal share in the monopoly rent. In this case the government anticipates no trade divergence as the home industry is expected to take maximum rent from consumerland. Bertrand competition models the other limiting case where intensity of competition is expected to be so strong that industry rent will be driven to zero[7]. The analysis for this limiting case is closely related to the case where the home firms are assumed to operate in a perfectly competitive industry. The government, in anticipation of Bertrand competition between home firms, will levy a tax per unit of output on each firm, by an amount equivalent to what would be the price over marginal cost margin of the home firms under Joint Profit Maximisation.

The more interesting case is the model of Cournot competition. For a small number of firms the government does not expect the intensity of competition to be strong. The government expects each firm to earn a price cost margin not too far below the Joint Profit Maximisation level. As the number of firms increase, the intensity of competition is expected to grow. In the limiting case this converges on the intensity of competition that we model when firms operate in a perfectly competitive industry or play the Bertrand strategy. In the following game we will model stage two assuming the firms play the Cournot strategy.

In the *second stage* the domestic firms choose x to maximise π, given c^*, holding the output of all the other home firms constant. We write down the first order condition for a home firm as the following:

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[7] N identical home firms produce a homogenous product. The Bertrand strategy for each firm is to choose a price such that its payoff is maximised, taking the prices of all the other firms as given. If a deviant $firm_i$ sets a price above the price of the other firms, the payoff for $firm_i$ is zero. A price below the price of the other firms the payoff for $firm_i$ is the monopoly rent. For any price equal to the price of the other firms the payoff for $firm_i$ is a share in the rent created. The Nash equilibrium in prices is a price equal to the unit variable cost of $firm_i$.

(9) $$\pi_x = P + xP_x - c^* = 0, \qquad \pi_{xx} < 0$$

Each home firm earns a supernormal rent. The solution function for x can be solved from the first order condition as $x^0(c , s) = (a - c^*)/(1+N)$. The industry produces $Q^C = N(a - c^*)/(1+N)$ in the simultaneous move Cournot equilibrium. As N gets bigger the output produced converges to that of a perfectly competitive industry $Q^{PC} = (a - c^*)$.

In the *first stage* the domestic government choose s to maximise G. This is in anticipation of the nature of competition in stage two. We write down the first order condition for the government as in (5), we note that $\pi_s = xP'(N-1).x_s + x$. We solve for the optimal subsidy as the following:

(10) $$s^o = P'x(N-1) < 0$$

The government finds it optimal to tax each firm by $s^o < 0$ per unit of output. The optimal tax induces each firm to produce 1/Nth of the monopoly output, $Q^m = (a-c)/2$. To see this substitute s^o in (10) into (8) and solve for $x^o = (a-c)/2N$. The industry is taxed back to the monopoly output. The monopoly rent is captured, partly by the firms in the home industry and partly in the guise of tax revenue. The optimal tax is again set to internalise an expected trade divergence that is a result of home competition over rent in consumerland. In this model the government anticipates that the home industry in free trade would take home supernormal rent but would not take home the maximum monopoly rent. From a social perspective, the government expects the home firm would underestimate the loss of revenue from inframarginal sales by P'x(N-1). The optimal tax on each firm forces each firm to produce the same output that it would produce under

Joint Profit Maximisation.

(11) $$s^o = P'x(N-1) = SMR - PMR < 0$$

The motive for intervention is to capture the maximum rent in consumerland in anticipation that the home firms would fail to do so, in the presence of intra-industry competition. What determines the level of the per unit tax? Using (8) and (9) we can re-express the optimal tax as follows:

(12) $$s^o = -(P^m - P^c) = SMR - PMR < 0$$

The level of the optimal tax is the difference between that which would be the price cost margin for each firm under Joint Profit Maximisation to that under free trade. The difference between these margins depends on two factors. First it depends on the potential rent that exists in consumerland for this industry. Secondly it depends on the intensity of competition that exists between the home firms over this rent. The tax captures the portion of the monopoly rent $t^oQ^m = (P^m - P^c)Q^m$. Each home firm takes home an equal share of the remainder. A general result has emerged from the above analysis. This is summaries in the following proposition.

Proposition 1: *The domestic government has an incentive to tax each firm in a home exporting industry by an amount equal to the wedge driven (by intra home industry competition) between the mark-up of a home firm under Joint Profit Maximisation to that under free trade.*

In figure 1:2 we summarise our main results for this section. A home industry is the sole seller into a foreign market, facing the demand curve D_o. The home government anticipates that competition between home firms will create a trade divergence. As a result, the home industry will not take home the maximum rent available in the foreign market. If there is a perfectly competitive home industry selling into this market the government anticipates that the home industry will set an output of Q^{PC} under conditions of free trade and earn zero economic rent for the home country. The government levies a per unit tax on each firm equivalent to what would be the mark-up of a monopoly firm selling into this foreign market. It levies a tax, $t^{PC}_o = P^m - c$, per unit of output as shown in figure 1:2. This shifts the industry supply curve up and induces a market clearing price that leads the perfectly competitive home industry to produce a level of output equivalent to that which would be produced by a monopoly firm. The home industry remains a zero rent industry but the monopoly rent is taken home by the government in the guise of tax revenue. This is presented in figure 1:2 by the shaded area a+b.

If the home government anticipates that competition between home firms is not perfectly competitive but allows each firm in the home industry to earn a certain mark-up of price over marginal cost, the policy response is the same. A tax must be imposed on each firm such that each firm has the same price cost margin as it would under Joint Profit Maximisation. Under conditions of free trade the industry can produce output anywhere in between the monopoly and the perfectly competitive output, depending on the intensity of competition modelled. In figure 1:2 we take an arbitrary outcome Q^*. This generates a market price of P^*. The government anticipates that the home industry, left to its own devices, would create a supernormal rent by an amount equivalent to the

shaded area a+c. The monopoly rent is given by the shaded area a+b and is greater than the area a+c. A tax is imposed on each home firm such that it produces a level of output equivalent to that which it produce under Joint Profit Maximisation. The tax levied on each firm is given by $t^*_o = P^m - P^*$. Part of the monopoly rent is taken home in the form of tax revenue by the area b and each home firm gets an equal share of the remainder (The shaded area a).

Section II: The New School and Export Policy

The set of players in this section consists of N identical home firms, M identical foreign firms and a domestic government. Initially, we abstract from having intra-industry competition between firms operating from the same country. We model this by setting $N = M = 1$. We then move on to show that the results hold for $M \geq N \geq 1$. As in section I, we model the behaviour of the firms and the domestic government in a series of two-stage games. We focus on *export* policy and model a trade divergence that results from the government's anticipation of *international* intra-industry competition over foreign rent and the detrimental effect it can have on home welfare.

One key element of this analysis is that the home government can only impose a policy instrument on the home firms. The government has full information on the nature of the competition between the firms in the foreign market. More importantly it knows the optimal response of the foreign firms to any action the government may decide to undertake. We model the government such that it anticipates *two* different types of responses by the foreign firms to its actions. In the first game the government anticipates that in response to giving the home firms a cost advantage, the foreign firms will find it optimal to reduce output and offer *partial price support.* Price support can be determined by factors other than the response of foreign firms. In general this represents any situation where the home government is aware of factors that hold the industry price up as the home firms expand output. The two-stage game we use to model this scenario is the same game used by Brander and Spencer (1985). We model the firms as playing the Cournot strategy in stage two of the game.

In the second game the government anticipates that in response to the prices set by the home firms, the foreign firms will find it optimal to follow the home firm's

actions. In general this represents any situation where the home government anticipates factors that relax competition as home firms contract their output. This can be determined by factors other than price competition. The two-stage game that models this scenario is the game used by Eaton and Grossman (1986). The firms play the Bertrand strategy in stage two of the game.

The Cournot two-stage game

N identical home firms and M identical foreign firms produce a homogeneous product. A home firm produces x and earns a payoff π. A foreign firm produces y and earns a payoff π^*. The inverse demand curve is assumed to be linear. We write it as the following:

(13) $$P = P(Q), \quad P'(Q) = -1 < 0$$

The payoff to a home firm is the same as (2). The payoff to a foreign firm is the following:

(14) $$\pi^* = (P(Q) - c^*)y$$

c^* is the foreign firm's unit variable cost. The foreign fixed cost of production is assumed to be zero. The payoff to the domestic government is the same as (3). Initially, we set N = M = 1. We rule out intra-industry competition between firms operating from the same country.

In the *second stage* the home firm chooses x to maximise π, given c^* and holds y constant. The foreign chooses y to maximise π^* given c^* and holds x constant. They

play *simultaneously*. The home firm's first and second order conditions are the following:

(15) $$\pi_x = P + xP' - c^* = 0, \qquad \pi_{xx} = 2P' < 0$$

(15) can be re-expressed as the optimal response function x = R(y). The foreign firm's first and second order conditions are as follows:

(16) $$\pi^*_y = P + yP' - c^* = 0, \qquad \pi^*_{yy} = 2P' < 0$$

This can also be re-expressed as the optimal response function $y = R^*(x)$. The following implies the uniqueness and stability of the Nash equilibrium:

(17) $$D \equiv \pi_{xx}\pi^*_{yy} - \pi_{xy}\pi^*_{yx} > 0, \qquad \pi_{xy} = \pi^*_{yx} = P' < 0$$

The solution functions for the output levels can be solved from the first order conditions (15) and (16). Take a total differential of (15) and (16) while holding c^* and c constant. Apply Cramer's Rule, we find the comparative static effects of a change in s.

(18) $$x^o(\, c\, ,\, c^*\, ,\, s\,), \qquad x_s = -\, \pi^*_{yy} / D > 0$$

$$y^o(\, c\, ,\, c^*\, ,\, s\,), \qquad y_s = \pi^*_{yx} / D < 0$$

In the *first stage* the domestic government chooses s to maximises G in

anticipation of the nature of competition in stage two. The first order condition for the government is the same as (5). Making use of the envelope theorem, we note that π_s = $P'xy_s$ + x. From the first order condition, we solve for the optimal subsidy. Taking a total differential of (14) while holding c^* constant implies that $dy/dx = - \pi^*_{yx}/\pi^*_{yy} = y_s/x_s < 0$. We can write down the optimal subsidy as the following:

$$(19) \qquad s^o = xP'dy/dx = SMR - PMR > 0$$

The optimal subsidy is signed using (13) and (18)[8]. The optimal subsidy in (19) induces the home firm to produce the output level that corresponds to the output level of a home firm with the benefit of first mover advantage. As a Stackelberg leader, the home firm would choose x to Max $\pi(x, y = R^*(x))$. The first order condition for this optimisation is the same as (15) when s^o in (19) is substituted into the home firm's first order condition. The set-up of our two-stage game ensures that the government anticipates a trade divergence in stage two of our model. The trade divergence is created by giving the home government first mover advantage. With a first mover advantage, the home government anticipates that the foreign firm would decrease its output and partially hold up the industry price if the home firm expanded its output. This would offset the revenue lost on inframarginal sales. From a social perspective, the government expects the home firm would *overestimate* the loss on inframarginal sales when it

[8] Neary (1991) shows that a subsidy becomes non-optimal under quantity competition for very low values of the shadow price of government funds. If $G = \pi - \delta sx$ where $\delta>1$, given the subsidy is optimal for $\delta=1$, it becomes non-optimal for low values of $\delta>1$.

produces output in the simultaneous move equilibrium[9]. This is what drives the wedge between the SMR and the PMR in home firm production. The motive for the subsidy is to exploit the price support offered by the foreign firm with the help of a transfer subsidy payment. What determines the magnitude of the per unit subsidy in the above model? We can go back to (19), using (18), this can be re-written as follows:

$$(20) \qquad s^{\circ} = \phi (c , c^{*}) : \; s^{\circ}_{c} < 0 , \; s^{\circ}_{c^{*}} > 0$$

This implies that the optimal subsidy is bigger the more cost competitive the home firm is relative to its foreign rival[10]. The more cost competitive the home firm, the greater government can exploit the *partial price support* that is being offered by the foreign firm in response to an expansion in the home firm's output. Hence the government anticipates a bigger welfare gain from intervention and is prepared to commit to a bigger transfer payment.

Next we allow intra-industry competition between firms operating from the same country. N identical home firms produce x and earn a payoff π and M identical foreign firms produce y and earns a payoff π^{*}. In the *second stage* a home firm chooses x to maximise π, given c^{*} and holds the output of all other firms constant. A foreign chooses

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[9] In the phraseology of Bulow et al (1985) output levels in this game are strategic substitutes.

[10] This is the Neary result (1991). Neary feels it is paradoxical to argue that governments should provide more help to the relatively profitable firm. He, as Brander and Spencer (1985) feels that in this type of model, the sole motive to subsidise is to *shift profits* from the foreign firm to the home firm. The more competitive the home firm, the higher the return to the home government from profit shifting. The fall in the foreign firm's profits and the rise in the home firm's profits is certainly an *outcome* of the above model.

y to maximise π^* given c^* and holds the output of all the other firms constant. They play *simultaneously*. A home firm's first and second order conditions are the same as those in (15) and a foreign firm's first and second order conditions are the same as those in (16). The solution function for the output of a home and a foreign firm and the partial derivative with respect to s can be obtained from the first order conditions. We express them as the following:

(21) $x^o = (a - (c-s)(1+M) + Mc^*)/(1 + M + N), \quad x_s = (1 + M)/(1 + M + N) > 0$

$y^o = (a - c^*(1+N) + N(c-s))/(1 + M + N), \quad y_s = - N /(1 + M + N) < 0$

In the *first stage* the domestic government chooses s to maximises G in anticipation of the nature of the game in stage two. The first order condition is the same as (5) in section I. We note that $\pi_s = - xMy_s - x(N-1)x_s + x$. From the first order condition, we solve for the optimal subsidy for each home firm using (15) and (21).

(22) $s^o = (P - c)((1 + M - N)/(1 + M)) = SMR - PMR > 0 , \quad M \geq N$

The optimal subsidy in (22) induces a home firm to produce an output level that corresponds to the output of a home firm that maximises *joint* home profits and has the benefit of first mover advantage over foreign firms. The first order condition for this optimisation is the same as (15) when we substitute s^o in (22) into (15).

The home government exploits the price support offered by the foreign firms to maximise the collective profits of the home industry. The subsidy given makes a

home firm take into account that when it expands output it causes the industry price to drop. This creates a negative externality which is suffered by all other home firms. This forces the home firm to make output decisions that maximises joint home profits. Secondly, when it expands output, it anticipates the optimal response of all foreign firms is to decrease their output. This offsets the fall in the industry price not just for that particular home firm but for *all* the home firms.

From a social perspective, the home firm would *overestimate* the loss on inframarginal sales when it expands output in a free trade equilibrium. This assumes that there are as many foreign firms as home firms in the industry (the price support effect is big enough) *and* that the home firms earn a positive mark-up (intra-industry competition is not to strong). Hence, the optimal subsidy given to each home firm will always be positive. The subsidy is also optimal in the long run equilibrium as long as the equilibrium level of concentration allows $M^* \geq N^*$ and an exogenous sunk cost of entering the industry allows the home firms to earn a positive mark-up.

Proposition 2: The optimal subsidy given to each home exporting firm under Cournot Competition is positive if $(P-c)/P > 0$ *and* $M \geq N$. *The optimal subsidy is increasing in the number of foreign firms that offer partial price support to the home industry. It is also decreasing in the intensity of international competition in the industry.*

There is a more general interpretation of this game[11]. The government

[11] Neary (1988) shows that export subsidies in any market structure lead to a direct welfare loss, due to a deterioration of the terms of trade. There can be by-product gains due to increasing returns or repercussions in markets for related goods(Feenstra (1988) and Itoh and Kiyono (1987)). In the above model there are gains in rent creation due to the price support being offered by the foreign firms operating in an imperfectly product

anticipates that in response to giving home firms a cost advantage, the foreign firms will find it optimal to offer partial price support. This does not have to be a result of foreign firm's responses. Rather, it could be due to *any* factor that ensures price support for this industry's product. A more general way of looking at the home government's decision is to write down the government's payoff in (3) in the following form, where we note that the subsidy payments themselves are in welfare terms transfer payments.

(23) $$G = N(\pi - sx) = N(P - c)x$$

The government asks itself whether it can exploit features specific to an industry to the advantage of home firms, thus enhancing home welfare. The first order condition for welfare maximisation with respect to a subsidy per unit of industry output is the following:

(24) $$G_s = N(xP_s + (P - c)x_s) = 0$$

A subsidy has two offsetting effects on the social returns from this industry. First, it causes the industry price to fall leading to a fall in each home firm's mark-up and hence a loss in social revenue from the home firm's inframarginal sales. Secondly, each home firm earns extra revenue from the additional output sold on a lower mark-up. This leads to a gain in societies welfare. In a cost-benefit analysis of whether or not the government should put a policy in place depends on two factors.

The first factor is the elasticity of the industry price with respect to the subsidy

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market.

$\eta_{Ps} < 0$. In the above model a feature *specific* to Cournot competition is that firms in their optimal response functions will cut production given that the other firm is expanding production. This leads η_{Ps} to be inelastic once $M \geq N$. The partial price support offered by foreign firms in response to home firms expansion in output will offset the welfare loss on the home industry's inframarginal sales.

Another feature of Cournot competition is that it allows the firms in an industry to earn a price over marginal cost mark-up. Given that there exists a mark-up for each home firm, there will be a welfare gain from the additional output of the home industry due to the subsidy. The bigger the mark-up ex-post intervention, the bigger the social gain from giving a subsidy per unit of output to each home firm. The government, in anticipation of both an inelastic η_{Ps} and high ex-post subsidy (P-c)/P for each home firm, has an incentive to subsidise home output.

In figure 1:3 we give a diagrammatic illustration of this result for $M = N = 1$. The home government anticipates that in the simultaneous move Cournot game the home firm would produce at x_0 and the foreign firm would produce at y_0. The demand curve $D_0(y_0)$ that the home firm faces in equilibrium is conditional on this foreign output level. The resulting industry price is given as P^C and the home firm earns a mark-up of (P-c). The home government, given a first mover advantage, anticipates a fall in social revenue on inframarginal sales as the home firm expands output in response to the subsidy. This is given by the area A. This fall in revenue is partially offset by the response of the foreign firm which shifts the demand curve the home firm faces outwards to the right. A response that offers the home firm industry price support as it expands output in response to the subsidy. The government anticipates that the home firm will earn extra revenue on the lower mark-up from selling the additional output. This is shown by the

area B in figure 1:3. Since B > A, a subsidy of one unit is beneficial. The optimal subsidy given to the home firm will set the area's $xP_s = (P - c)x_s$.

The government in anticipation of both an inelastic η_{Ps} and high ex-post subsidy (P-c)/P for each home firm will have an incentive to grant a subsidy to home firms. We have shown that Cournot competition can be used to model both an inelastic η_{Ps} and high ex-post subsidy (P-c)/P for each home firm. Cournot competition is not an observable feature of industries. However, factors which cause η_{Ps} to be inelastic and (P - c)/P to be large are observable features of industries. Nogues et al (1985) in their study of Non Tariff Barriers (NTB's) across industries and countries, found that NTB's coverage (in subsidies) for agricultural products, is much higher compared with manufactured products in industrial countries. This observation is consistent with the idea that in agriculture there is some form of price support (especially in EEC countries) that ensures that η_{Ps} is low within industries that produce agricultural products. However, the price support given to countries that export agricultural goods is not offered by the response of foreign competitors as modelled by Cournot competition. Rather, it results from an agreement between governments that is motivated by political economy considerations. There is also a fair rate of return guaranteed on agricultural products ex-post intervention. These two simple factors explain why we observe governments engaging in the rent seeking activity of giving subsidies to industries that produce agricultural products in industrialised nations.

The Bertrand two stage game

N identical home firms and M identical foreign firms produce a homogeneous product. A home firm produces x at a price P and earns a payoff π, while a foreign firm produces y at a price P^* and earns a payoff π^*. The demand conditions are derived with

an application of Salop's (1979)a model. Consumers are located uniformly on a circle with a perimeter equal to one and the density of consumers is unitary around the circle. The firms are located symmetrically around the circle. There is an equal number of home and foreign firms that alternate in location around the circle. The distance between any home and foreign firm located on the circle is equal to 1/(M+N). Each consumer buys one unit of the good and has a transport cost τ per unit of the distance travelled to each location. Sales for a home firm are equal to 2d, where d is the per unit distance from the consumer who is indifferent between travelling to a home or a foreign firm location on the circle. The equation of the *indifferent consumer* for a home firm's product is $P + \tau d = P^* + \tau(1/(M+N) - d)$. We solve for a home firm's demand function as the following:

$$2d = x = x(P, P^*) = 1/(M+N) + (P^* - P)/\tau \tag{25}$$

The equation of the indifferent consumer for a foreign firm's product is $P^* + \tau d = P + \tau(1/(M+N) - d)$. We can solve for a foreign firm's demand function as the following:

$$2d = y = y(P, P^*) = 1/(M+N) + (P - P^*)/\tau \tag{26}$$

Let $c^* = (c-s)$ be the variable cost of production net of subsidy per unit of output[12]. We write the payoff to a home firm as:

[12] Carmichael (1987) makes an empirical observation that a subsidy is targeted at a price secured on an export contract rather than on the volume of sales. Neary (1990) shows that the effect of a subsidy targeted at price or output is the same in this type of framework.

(27) $$\pi = (P - c^{\cdot})x(P , P^{*})$$

Let c^{*} be the variable cost of foreign production. We write the payoff to a foreign firm as:

(28) $$\pi^{*} = (P^{*} - c^{*})y(P , P^{*})$$

The payoff to the domestic government is the same payoff as (3). Initially, we set M = N = 1. We rule out intra-industry competition between firms operating from the same country. In the *second* stage the home firm chooses P to maximise π given $c^{\cdot}$ and holds P^{*} constant. The foreign firms strategy is to choose P^{*} to maximise π^{*} given c^{*} and holds P constant. They play *simultaneously.* The domestic firm's first and second order conditions are the following:

(29) $$\pi_{p} = (P - c^{\cdot})x_{p} + x = 0, \qquad \pi_{pp} < 0$$

(29) can be re-expressed as the optimal response function $P = R(P^{*})$. The foreign firm's first and second order conditions are the following:

(30) $$\pi^{*}_{p^{*}} = (P^{*} - c^{*})y_{p^{*}} + y = 0, \qquad \pi^{*}_{p^{*}p^{*}} < 0$$

This can also be expressed as the optimal response function $P^{*} = R^{*}(P)$. The followingimplies uniqueness and stability of the Nash equilibrium:

(31) $$D \equiv \pi_{pp}\pi^{*}_{p^{*}p^{*}} - \pi_{pp^{*}}\pi^{*}_{p^{*}p} > 0 , \qquad \pi_{pp^{*}} = \pi^{*}_{p^{*}p} > 0$$

The solution functions for the prices can be solved from the first order conditions (29) and (30). Take a total differential of (29) and (30) while holding c^* and c constant. Apply Cramer's Rule, we find the comparative static effects of a change in s:

(32) $$P^o(\, c\, ,\, c^*,\, s,\, \tau\,), \qquad P_s = -\, x_p \pi^*_{p^*p^*} / D \;= -2/3 < 0$$

$$P^{*o}(\, c\, ,\, c^*,\, s,\, \tau\,), \qquad P^*_s = \; x_p \pi^*_{p^*p} / D \;= -1/3 < 0$$

In the *first stage* the domestic government chooses s to maximises G in anticipation of the nature of the game in stage two. The first order condition is the same as (5). Making use of the envelope theorem, we note that $\pi_s = (P - c^*)x_{p^*}P^*_s + x$. Taking a total differential of (28) while holding c^* constant implies that $dP^*/dP = P^*_s / P_s = -\pi^*_{p^*p} / \pi^*_{p^*p^*} > 0$. We write down the optimal subsidy as the following.

(33) $$s^O \;= (P - c)(x_{p^*}/x_p)(dP^*/dP) = -\,(P - c)/2 \;= \text{SMR} - \text{PMR} < 0$$

The optimal tax is signed using (29) and (32). The optimal tax in (33) induces the home firm to produce an output level that corresponds to the output level of a home firm with the benefit of first mover advantage. As a Stackelberg leader, the home firm would set a price to Max $\pi(P, P^* = R^*(P))$. In setting its price, it anticipates the optimal response function of the foreign firm. The first order condition for this optimisation is the same as (29) when s^o in (33) is substituted into the home firm's first order condition. The trade divergence results from giving the home government first mover advantage. With a first mover advantage, the home firm government anticipates that the foreign

firm will partially price follow in response to any price the home firm sets. This would reinforce the fall in the home firm's price as it expanded output and add to the revenue lost on inframarginal sales. The government is looking at the game with this point of view. From a social perspective, the government expects the home firm would *underestimate* the loss on inframarginal sales when it produces in a simultaneous move Bertrand equilibrium[13]. This is what creates the trade divergence in home production. The motive for intervention is to exploit the price following offered by the foreign firm. What determines the magnitude of the tax levied in the above model? We can go back to (33), using (25) and (29), we rewrite it as the following:

$$(34) \qquad t^o = \phi (\tau , (c^* - c)), \; t^o_\tau = 1/4 > 0 , \; t^o_{(c^* - c)} = 1/6 > 0$$

This implies that the optimal tax (t^o) is a increasing function of the consumer's per unit transport cost of travelling to a firm's location. To a lesser extent an increasing function of how cost competitive the home firm is relative to the foreign firm. Both these factors dictate how profitable the home firm is in the simultaneous move Bertrand equilibrium. The more profitable the home firm, the more the government can exploit the price following that is being offered by the foreign firm. Hence it anticipates a bigger welfare gain from intervention and commits itself to levy a bigger per unit of output tax on the home firm[14].

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[13] In the phraseology of Bulow et al (1985) price levels in this game are strategic complements.

[14] The trade divergence is bigger, the more profitable the home firm is in the simultaneous move Bertrand equilibrium. There is a simple limit theorem present in this two-stage game. As τ falls to zero, profit and hence the trade divergence falls to zero. For there to be any benefit of first mover advantage in this two-stage game, the

Next we allow intra-industry competition between firms operating from the same country M = N > 1. We make use of the demand conditions and payoffs in the above game. In the *second* stage a home firm chooses P to maximise π given c^* and holds the prices of all other firms in the industry constant. A foreign firms strategy is to choose P^* to maximise π^* given c^* and holds the prices of all other firms in the industry constant. They play *simultaneously*. A home firm's first and second order conditions are the same as those in (29) and a foreign firm's first and second order conditions are the same as those in (30). The solution functions for the prices and the comparative static effects of a change in s can be obtained from the first order conditions. We express them as the following:

(35) $$P^o(c , c^* , s, \tau/(M+N)), \quad P_s = -2/3 < 0$$

$$P^{*o}(c , c^*, s, \tau/(M+N)), \quad P^*_s = -1/3 < 0$$

In the *first stage* the domestic government chooses s to maximises G in anticipation of the nature of the game in stage two. The first order condition is the same as (5) in section I. We can solve for the optimal subsidy. This is expressed in the same way as in (33). The optimal tax in (33) induces a home firm to produce the output of a home firm with the benefit of first mover advantage over the foreign firms on either side of its location. By maximising its profits on its location, the home firm maximises the joint profits of the home firms. The home government exploits the price following

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government must anticipate rent for the home firm in the simultaneous move equilibrium.

offered by the foreign firms to maximise the collective profits of the home industry. The tax levied makes a home firm take into account that as it expands output the optimal response of the foreign firms will be to price follow. This will reinforce the fall in the price received by the home firms as they expand output. From the social perspective, the government expects the home firm would *underestimate* the loss on inframarginal sales when they expands output in the free trade equilibrium. This assumes there are as many foreign firms as home firms (the price following effect is big enough) *and* that each home firm earns a positive price cost mark-up. Hence a tax levied on each home firm will be optimal. The tax is also optimal in the long run equilibrium once $M^* = N^*$ in the equilibrium and there is some exogenous sunk cost of entering the industry to ensure home firms earn a positive mark-up in long run equilibrium.

What determines the magnitude of the tax levied on each firm in the above case? We go back to (33), using (25) and (29) we rewrite as the following:

(36) $$t^o = \phi\,(\,\tau/(M+N)\,,\,(c^* - c)\,), \quad t^o_{\tau/(M+N)} = 1/2 > 0\,, \quad t^o_{(c^*-c)} = 1/6 > 0$$

Proposition 3: *The optimal tax levy on each home firm under international Bertrand competition is positive if $(P-c)/P > 0$ and $M=N$. The tax levy is greater the more cost competitive a home firm is relative to its foreign rivals and to a greater extent the more differentiated its product.*

Product differentiation in this model depends on the size of the per unit transport cost to the consumer of travelling to a location. It also depends on the distance that must be travelled to another location that sells the homogenous product. The more firms that are

located symmetrically around the circle, the smaller the distance a consumer has to travel to a location. Both these factors dictate the premium, that consumers are prepared to pay for the convenience of location. Given first mover advantage, the home government exploits the price following response of the foreign firms, on either side of a home firm's location. The more profitable the home firm's in the simultaneous Bertrand equilibrium the bigger the welfare gain to doing this.

There is a more general interpretation of this game. The government anticipates that if the home firms increase their price, the foreign firms will find it optimal to raise their price and partially offset the fall in demand for home output. This does not have to a result of foreign firms responses. Rather, it could be due to *any* factor that holds up the demand for the home output as the price for the home good rises. A more general way of looking at the home government's decision is to write down the government's first order condition for welfare maximisation with respect to a subsidy as in (24). The government, given first mover advantage, asks itself wether it can exploit features specific to an industry to advantage of home firms, thus enhancing home welfare. Its decision depends on two factors.

The first factor is the elasticity of the industry price with respect to the subsidy $\eta_{Ps} < 0$. In the above model a feature *specific* to Bertrand competition is that firm's in their optimal response functions will always set a lower price, given that the other firm is setting a lower price. Hence the home government anticipates η_{Ps} to be *elastic*, once M = N. Another feature of the above model is that it allows each home firm to earn a price cost mark-up. The benefit of the subsidy is that the each home firm will earn extra revenue on the lower mark-up from selling additional output. The government, in anticipation of both an elastic η_{Ps} and low ex-post subsidy (P - c)/P for each home firm,

has an incentive to commit each home firm to a higher price with a tax per unit of home firm output.

In figure 1:4 we give a diagrammatic illustration of this result for M = N = 1. The home government anticipates that the home firm in the simultaneous move Bertrand game would produce at x_0 and the foreign firm would produce at y_0. The demand curve $D_0(P^*_0)$ that the home firm faces in equilibrium is conditional on the foreign price level. The resulting industry price is given as P^B and the home firm earns a mark-up (P - c) that is increasing in τ and (c^* - c). The home government, given first mover advantage, anticipates a fall in social revenue on inframarginal sales in response to the subsidy. This is reinforced by the optimal response of the foreign firm, which shifts in the demand curve the home firm faces to the left. This has a price dumping effect, when the home firm expands output in response to the subsidy. This is shown by the shaded area A in figure 1:4. The gain in social revenue due to the subsidy will be the extra revenue on the lower mark-up from selling additional output. This is shown by the shaded area B. Since A > B, a tax of one unit is beneficial to home welfare. The optimal tax levied on the home firm will set the area's $xP_s = (P - c)_s : s^o < 0$.

The government in anticipation of both an elastic $\eta_{Pt} > 0$ and high ex-post tax (P-c)/P for each home firm will have the incentive to contract home output with a tax. We have shown that Bertrand competition can used to model both an elastic η_{Pt} and high ex-post tax (P-c)/P for each home firm. Bertrand competition is not an observable feature of industries. However, factors that cause η_{Pt} to be elastic and (P - c)/P to be potentially small under conditions of free trade are observable features of industries. In there study of Non Tariff Barriers (NTB's) across industries and countries Nogues et al (1985) found that NTB's coverage, especially VER's, was highest in the manufactured products

of Textiles, Iron and Steel, and Vehicles. These are relatively homogenous product industries. The intensity of competition in these industries is potentially very high leading to potentially low (P-c)/P for exporting firms. In addition, there is an agreement among governments that ensures foreign firms will follow the lead taken by the home firms in setting price. These two simple factors explain why we observe VER's in these products in industrial nations. The guarantee of price following by foreign competitors is enforced by the foreign government as a result of an agreement with the home government and is not voluntary as we modelled above. The home government does not enforce the export restraint with a tax but with a legal restraint with allows the home firms to take home all the additional rent created. This agreement is motivated by political economy considerations as a result of rent seeking activities.

Conclusion

In this chapter we recast the analyses of the old and new schools of international trade theory and show now they both build an endogenous trade divergence into their analysis. A trade divergence is modelled in the old school by allowing the home government to anticipate intra *home* industry competition in a foreign market and the detrimental effect it can have on home welfare. The home government levies a tax on each home firm to ensure that maximum rent is taken from the foreign market. The magnitude of intervention depends *positively* on the intensity of intra home industry competition in the foreign market.

A trade divergence is modelled in the new school by allowing the home government to anticipate *international* intra-industry competition in a foreign market and the detrimental effect it can have on home welfare. A subsidy for each home firm is optimal when the government anticipates *price support* and positive price cost margins

ex-post intervention for each home firm. A restraint on home firm output becomes optimal when the government anticipates *price following* by foreign firms and positive ex-post intervention price cost margins for home firms. The magnitude of intervention in the new school depends *negatively* on the intensity of intra home industry competition in the foreign market.

We have shown that Cournot competition can be used to model both price support and high ex-post subsidy price cost margins for each home firm. We generalise the use of Cournot competition to represent *any* factor that leads to price support and high ex-post intervention price cost margins. In agriculture there is some form of price support (especially in EEC countries). There is also a fair rate of return guaranteed on agricultural products ex-post intervention. These two simple factors explain why we observe governments giving subsidies to industries that produce agricultural products in industrialised nations.

We have shown that Bertrand competition can be used to model both price following by foreign firms and high ex-post tax price cost margins for each home firm. This analysis explains why governments, in a certain class of manufacturing export industries, voluntarily restrain the exports of home firms when they are guaranteed that foreign firms will price follow and high ex-post intervention price cost margins.

FIGURE 1:1

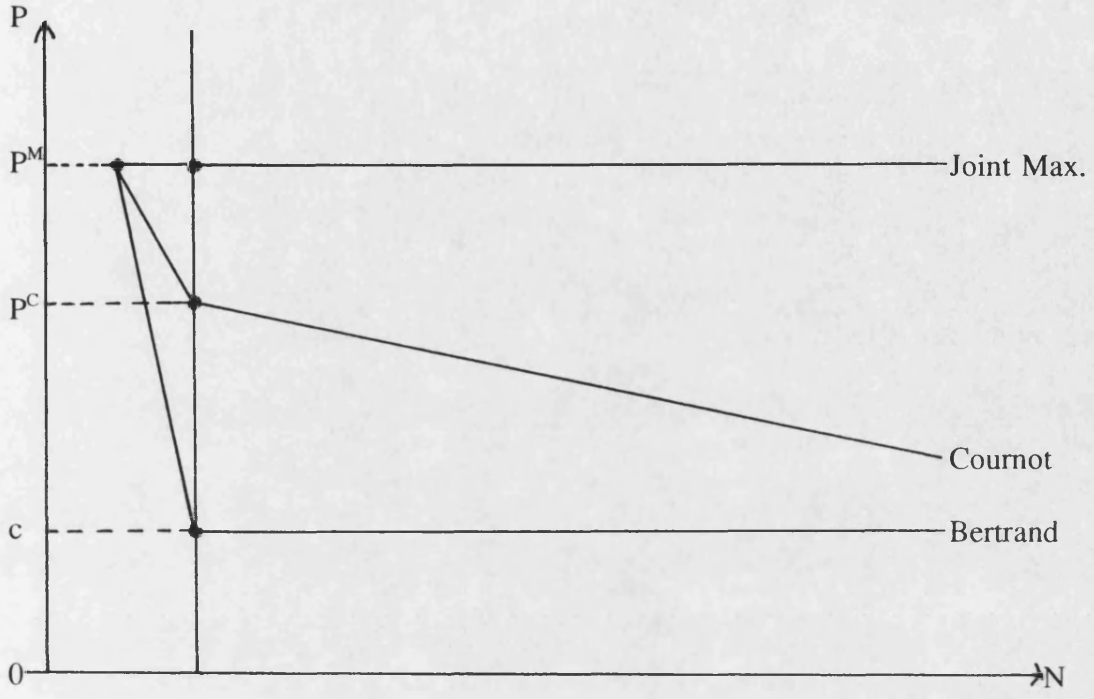


FIGURE 1:2

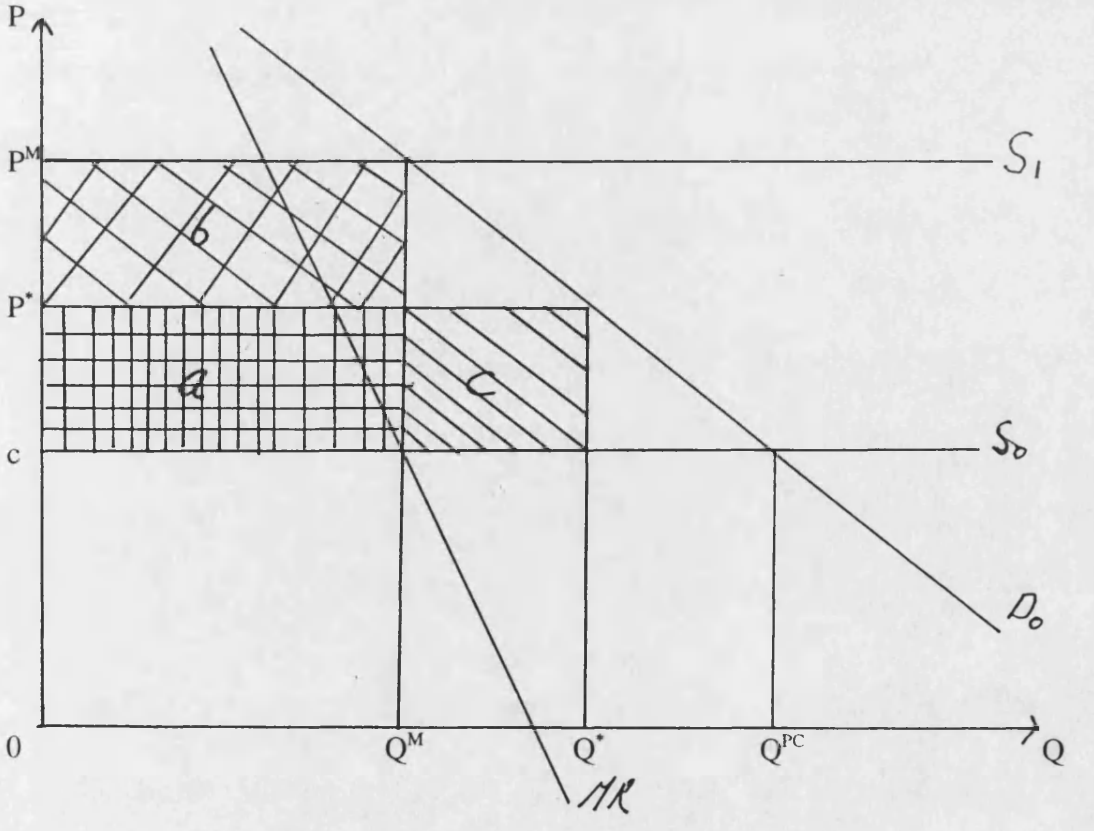


FIGURE 1:3

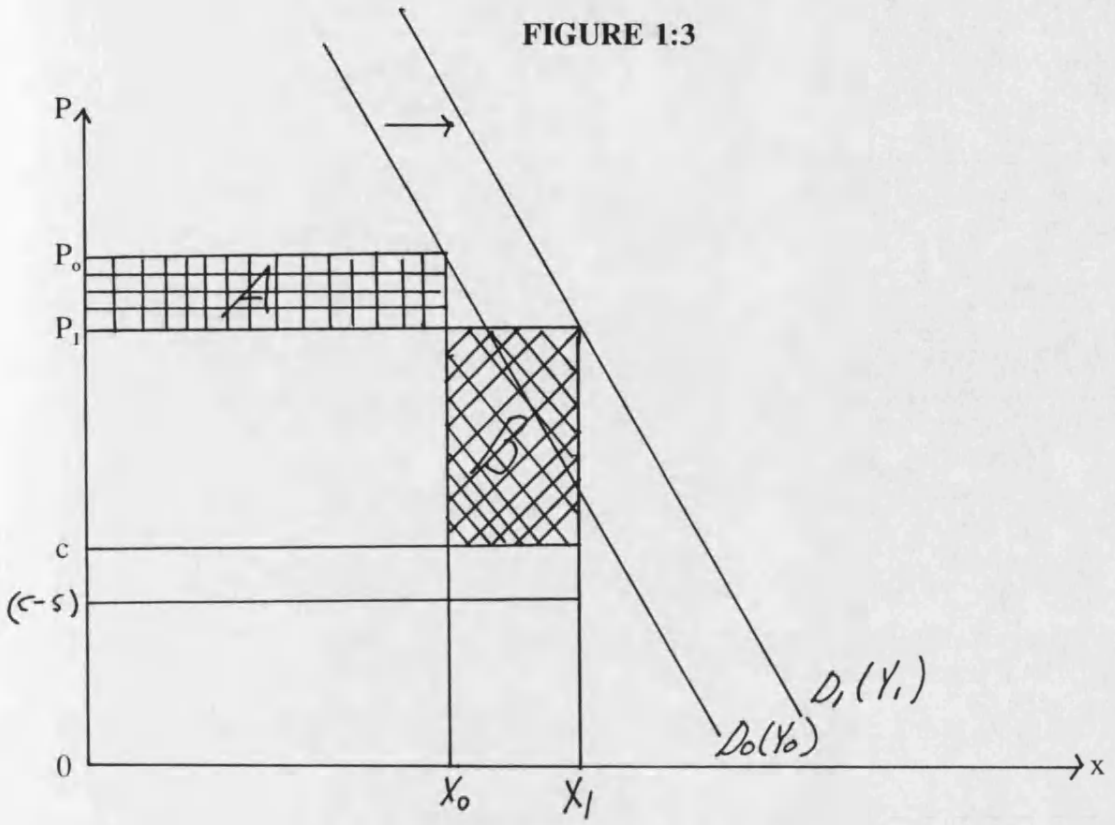
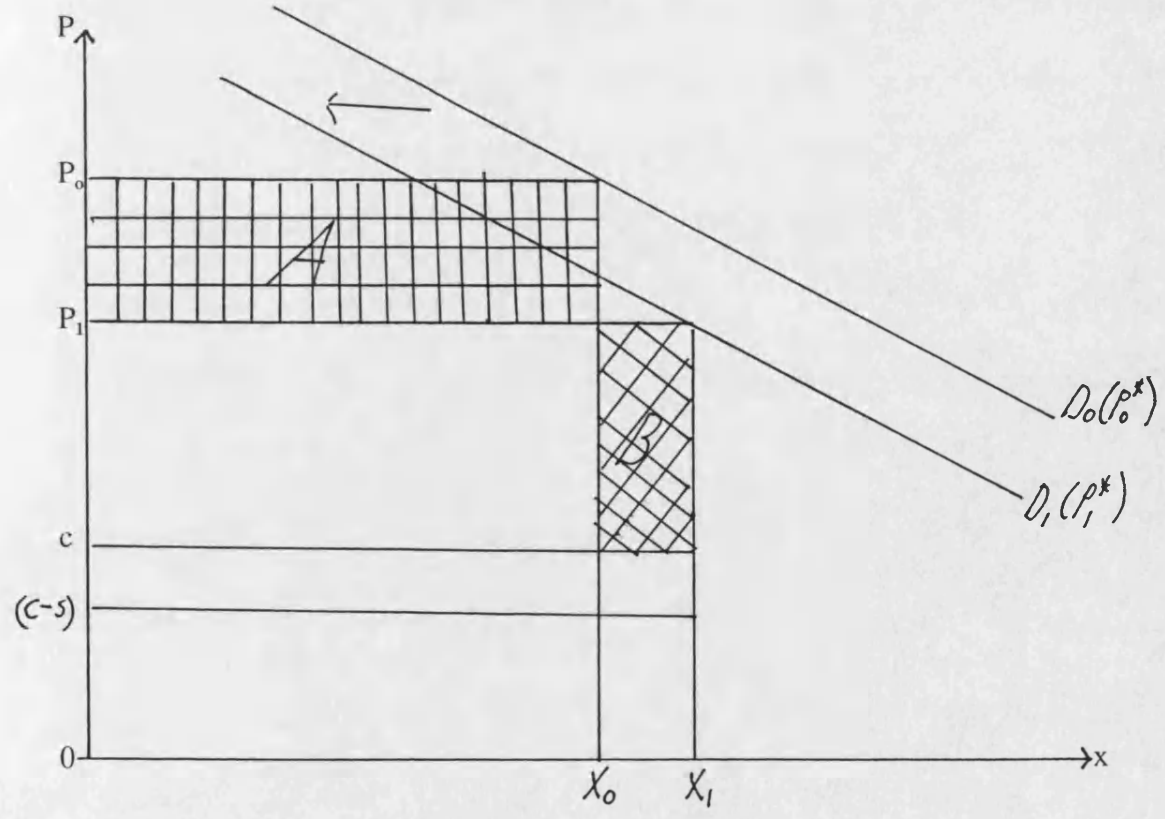


FIGURE 1:4



CHAPTER 2

UNIONISED INTRA-INDUSTRY COMPETITION AND TRADE POLICY

INTRODUCTION

In this chapter we examine trade policy in the old and new schools of international trade theory under unionised intra-industry competition. The focus of what we call the old school of international trade is to examine trade policy in the presence of unionised intra-industry competition between *home* firms. The focus of what we call the new school is to examine trade policy in the presence of *international* intra-industry competition. We build endogenous trade and domestic divergences into the analysis of both schools[1]. An endogenous trade divergence is modelled with intra-industry competition and an endogenous domestic divergence is modelled using a wage bargaining process.

We analyse the *old school* and trade policy in section I. We first focus on *export* policy. The home firms operate in a foreign market, which we call "consumerland". The home government is modelled to anticipate both a trade and a domestic divergence in the free trade equilibrium. Corden's trade divergence results from the government's anticipation of intra-industry competition over rent in consumerland and the detrimental effect it has on home welfare. The government anticipates that under conditions of free trade the home industry would fail to take home the monopoly rent from consumerland. Meade's domestic divergence results from the government's anticipation of *wage bargaining* over the rent created in consumerland and the detrimental effect it has on welfare. The government anticipates that the home firms will not treat the rent component of a wage bill as a social benefit of production. Following Sah and Stiglitz (1985), we include it in social surplus, on the grounds that this is rent generated within

[1] We define a *trade divergence* as in chapter one. Meade, in his book on "Trade and Welfare" (1955), defines a *domestic divergence* as a divergence between the social marginal cost and private marginal cost of home firm production.

the industry. The government anticipates that in the free trade equilibrium, maximum industry rent (including labour rent) will not be captured by the home industry. In anticipation of this the government undertakes measures ensuring that maximum rent (both labour and firm rent), even in the presence of imperfect competition and wage bargaining, is generated within the industry and taken from consumerland. The optimal subsidy to a unionised home firm in an exporting industry can be positive or negative. The optimal subsidy is positive when intra-industry competition is weak and unions are strong in the bargaining process. Both these factors make an industry a high wage premium industry. Under these conditions the government has an incentive to increase social surplus by drawing workers into this high wage premium industry, even at the cost of a deterioration in the terms of trade.

The focus of section I then changes to examine *domestic* policy. The home firms are assumed to operate only in the domestic market. The government is modelled to anticipate both a consumption and a domestic divergence in the free trade equilibrium. The government anticipates that under conditions of free trade, a consumption divergence would result due to the lack of intra home industry competition. The government also anticipates that a domestic divergence would result in the free trade equilibrium due to the presence of *wage bargaining* in the home industry. An optimal subsidy is given to each home firm such that it produces an output level that corresponds to the output of a home firm equating P = SMC under conditions of free trade. This maximises the sum of *joint* home firm profits, labour rents and consumer surplus in the domestic market. Free trade is only optimal in the limiting case of perfect intra-industry competition.

We analyse the *new school* and trade policy in section II. In this section, the

industry consists of one unionised home firm and a non-unionised foreign firm. We abstract from having intra-industry competition between firms from the same country. First we focus on *export* policy and model the home government to anticipate both a trade and a domestic divergence in the free trade equilibrium. Corden's trade divergence results from the government's anticipation of *international* intra-industry competition over foreign rent and the detrimental effect it has on home welfare. Meade's domestic divergence results from the government's anticipation of the detrimental effect *wage bargaining* over rent created in the foreign market has on welfare. One key element of this analysis is that the home government can only impose its policy on the home firm. The response of the foreign firm to government action can be an important factor that determines policy. We examine export policy where the firms can either play the Cournot or Bertrand Strategy. The optimal subsidy to the unionised exporting firm facing international Cournot competition is positive. When facing international Betrand competition, the subsidy can be negative or positive. In both of the above cases, as in the old school, the optimal subsidy is positive when international intra-industry competition is weak and the union is strong in bargaining. Both these factors make this industry a high wage premium industry. Under these conditions, the government has an incentive to increase social surplus by pulling workers into this high wage premium industry.

The focus of section II then changes to examine *domestic* policy, where the unionised home firm and the non-unionised foreign firm are assumed to operate in the domestic market. Whether firms play the Cournot or Bertrand strategy is not an important factor determining domestic policy in section II. Here the home government has a choice in the policy instrument it may use. The home government is modelled to

anticipate both a consumption and a domestic divergence in the free trade equilibrium. The consumption divergence results from the government's anticipation of imperfect international intra-industry competition. The domestic divergence results from the government's anticipation of wage bargaining in the home firm. As in the old school, the government, in anticipation of both these factors, can use a transfer subsidy payment to the home firm ensuring that the industry produces output at the socially optimal Bliss point, even in the presence of imperfect *international* competition and wage bargaining.

The presence of international competition allows the government to consider imposing a tariff on the foreign firm. A tariff on the foreign firm is also optimal. Rather than push the equilibrium towards the Bliss point it induces the industry to produce the output of a non-unionised monopoly firm. Hence, the tariff is always a second best policy instrument. Monopoly rents are generated for the home country in the guise of increased home firm rent, labour rent and tax revenue at the cost of a decrease in consumer surplus. This is a preferred situation compared to the free trade equilibrium. Free trade in this framework does not generate sufficient international competition due to drive industry output to the Bliss point and becomes the third best equilibrium outcome.

Section I: The Old School and Trade Policy

The set of players in this section consists of N unionised home firms and a domestic government. The N identical unionised home firms produce a homogeneous product with one factor of production, labour. A home firm produces X with a simple technology $X = L$ and earns a payoff π. The inverse demand curve is assumed to be the following:

(1) $$P(Q) = 1 - Q, \qquad P' < 0$$

Let $c = (w - s)$ be the home firm's unit wage cost net of a subsidy per unit of output (labour). Let fixed costs of production be zero. We write the payoff to a home firm as:

(2) $$\pi = (P(Q) - c)L$$

Let A be the outside option for the home industry's workers. The unions are risk neutral and only get utility from a wage above the outside option for its workers. They maximise the following payoff function:

(3) $$U(w) = (w - A)$$

The presence of unions ensures that domestic labour earn rent. The government should not treat the rent component of a wage bill as a social cost of production. It should be included in social surplus as rent generated within the industry. Let V(P,b) be an indirect utility function for a representative consumer in the domestic market. The government is assumed to give equal weighting to all components of the following welfare function when evaluating welfare.

(4) $$G = N(\pi + (w-A)L - sL) + KV(P,b)$$

The government sets $K = 0$ in the evaluation of export policy and sets $K = 1$ in the evaluation of domestic policy. We will look at the behaviour of the home firms and the

government in a series of two-stage games. We model the unionised firms to as operating in an oligopolistic home export industry. In all cases the government moves first and is assumed to understand the dependence of the second stage on the first when choosing the optimal subsidy. This will lead to a Nash equilibrium in each subgame. Within a generalised bargaining framework we can model the unions to have various bargaining strengths when appropriating product market rent to labour. To model various intensities of competition and hence various equilibrium price cost margins in the in the product market, we follow the approach taken in chapter one. The model of Joint Profit Maximisation is a limiting case. In this case the government expects no intra home industry competition over rent in consumerland and hence no trade divergence. Yet the presence of wage bargaining leads the government to expect a domestic divergence. Bargaining drives a wedge between the private and social marginal costs of production. A subsidy of (w-A) is given to each firm insuring that maximum industry rent is captured in consumerland. Industry rent to the home government represents the sum of both firm and labour rents. In the case where the home industry produces solely for the domestic market, the government expects Joint Profit Maximisation to push the consumption and domestic divergence to their perspective upper limit. A subsidy is given to each firm to ensure that employment is set at a level equal to the employment set by a home firm that equates price to social marginal cost. Even in the presence of Joint Profit Maximisation and wage bargaining in the home industry, the subsidy ensures that we reach a point of allocative efficiency in the home country.

Bertrand competition models the other limiting case of perfect intra-industry competition. All rents are expected to be driven to zero in the free trade equilibrium. This models a case where the trade divergence is at a maximum and the domestic

divergence is zero. The government, in anticipation of perfect intra home industry competition between unionised home firms in a foreign market, will levy a tax per unit of output tax on each firm by an amount equivalent to that which would be the price over social marginal cost margin of the home firms under Joint Profit Maximisation. This captures that which would be the rent of a non-unionised monopoly firm in the guise of tax revenue. In anticipation of perfect unionised intra-home industry competition in the domestic market the government will expect no consumption or domestic divergence in the free trade equilibrium.

The more interesting case is the model of Cournot competition. Unlike the above limiting cases, Cournot competition allows us to model the presence of both a trade and domestic divergence when we examine export policy. It allows us to model the presence of both a consumption and a domestic divergence when we examine domestic policy. In the following game we will model stage two, assuming that the unionised firms play the Cournot strategy.

In the *second stage*, a home firm bargains with its union over the wage level. Bargaining is over the wage only and the firms retain the *Right To Manage* (the right to set employment). Given (3), efficient contracts will lie on the labour demand curve[2]. Simultaneous to the wage bargaining process, the firms set their employment levels.

To model *wage setting* in a home firm we use the (generalised) asymmetric Nash bargaining solution for (two player) non-cooperative bargaining environments. This approximates the unique perfect equilibrium outcome of a strategic time preference

[2] Evidence is found in both the US and the UK for this assumption, Farber (1986), Oswald (1987), Clark and Oswald (1989) and Layard et al (1991).

model[3]. The Nash bargaining solution is obtained by maximising the Nash product of the payoff functions for the two parties net of opportunity costs (threat points). We express the generalised Nash product as the following:

(5) $$\Omega = (U - U^{\bullet})^{\beta}(\pi - \pi^{\bullet})^{1-\beta}, \qquad 0 < \beta < 1$$

$U^{\bullet}$ is the opportunity cost to a union and $\pi^{\bullet}$ is the opportunity cost to a home firm. The threat points in this model are $(U^{\bullet}, \pi^{\bullet}) = (0, 0)$[4]. The relative bargaining power of the union goes up as β approaches one[5]. Working with the above, we rewrite (5) and (3) as the following.

(6) $$\Omega = (w - A)^{\beta}\pi^{1-\beta}$$

To get the Nash bargaining solution we maximise (6) with respect to w, given s, holding Q constant. The first order condition can be re-expressed the optimal response $w = R^{\bullet}(L)$.

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[3] As the delay between offers approaches zero, the limit of the subgame perfect equilibria of the bargaining game can be calculated using the asymmetric Nash Solution (Binmore et al (1986) and Osborne and Rubinstein (1990)).

[4] The outside option in our model enters directly into the preferences of the union. A threat point cannot correspond to an outside option (see Sutton (1986)). The inclusion of the outside option only affects the equilibrium outcome of the strategic models if one of the parties prefers the outside option point to one of the agreement points. Otherwise the threat to leave the bargain would not credible.

[5] The asymmetry cannot be due to asymmetries in preferences or disagreement points in the strategic model that the Nash solution is approximating (as they disappear in the limiting equilibrium outcomes). Rather it is due to the bargaining procedure or to parties beliefs about some determinants of the bargaining environment.(see Osbourne and Rubinstein (1990)).

(7) $$\Omega_w = ß/(w - A) + ((1-ß)/\pi)\pi_w = 0, \qquad \Omega_{ww} < 0$$

The wage is set in an efficient bargain. The workers get a share in the product market rent. This share depends on the relative bargaining strength of the union.

Employment setting is modelled simultaneously to the bargaining process. A home firm chooses L to maximise π, given s, holding w and L(N-1) constant. The first order condition for a home firm can be re-expressed as the optimal response function $L = R^{\bullet}(w)$.

(8) $$\pi_L = P + LP_L - c = 0, \qquad \pi_{LL} < 0$$

The following holds and ensures uniqueness and stability of the wage and employment setting equilibrium .

(9) $$D = \Omega_{ww}\pi_{LL} - \Omega_{wL}\pi_{Lw} > 0$$

The solution functions for the wage and employment levels can be derived from the optimal response functions (7) and (8) and we find the comparative static effects of changes in s.

(10) $$w^{O}(A, ß, s, N), \qquad w_s = ß/(1 + N(1-ß)) > 0$$

$$L^{O}(A, ß, s, N), \qquad L_s = (1-ß)/(1 + N(1-ß)) > 0$$

In the *first stage*, the domestic government chooses s to maximise (4) in anticipation of the nature of competition in stage two. Using Roy's Identity and setting the marginal utility of income equal to one, we write down the first order condition for the government as,

$$(11) \qquad G_s = N(\pi_s + (w\text{-}A)L_s + Lw_s - sL_s - L) - KQP_s = 0$$

First we examine *export* policy. We note that $\pi_s = LP'(N-1)L_s - Lw_s + L$. We set $K = 0$ and solve for the optimal export subsidy,

$$(12) \qquad s^o = P'L(N-1) + (w - A) = (SMR - PMR) + (SMC - PMC)$$

The optimal subsidy is set to internalise an expected trade and domestic divergence that would result in the free trade equilibrium. If we substitute s^o in (12) into (8) the home firm is given an incentive to set an employment level such that the *sum* of *joint* home firm and labour rents are maximised. The home firm is induced to take into account that as it expands output the industry price will fall, leading to a negative effect on the revenue of all other home firms. The home firm is also induced to give an equal weighting to labour rent in its payoff function. From a social perspective, the government expects a home firm to *underestimate* the loss of revenue from inframarginal sales by P'L(N-1) and *overestimate* the marginal cost of production by (w-A). A tax is the optimal policy to internalise the trade divergence and a subsidy is the optimal policy to internalise the domestic divergence. Using (7) and (8) we can rewrite (12) in the following form:

(13) $$s^o = (w - A)(1-N(1-ß))/ß)$$

The sign of the optimal subsidy depends on the intensity of intra home industry competition (N) and on the bargaining strength of the unions (ß). A subsidy ($s^o > 0$) is optimal if $N(1-ß) < 1$, free trade ($s^o = 0$) is optimal if $N(1-ß) = 1$, and a tax ($s^o < 0$) is optimal if $N(1-ß) > 1$. The motive for intervention is to capture the maximum industry rent (firm and labour) in consumerland in anticipation that home firms would fail to do so as a result of unionised intra-industry competition. What determines the magnitude of intervention? We can re-express the optimal subsidy as the following:

(14) $$s^o = - (P^m - P^c) + (w - A)$$

The level of the optimal subsidy depends negatively on the difference between the price cost margin of a firm under Joint Profit Maximisation to that under free trade. It depends positively on the wage mark-up. The first gap depends positively on the intensity of intra home industry competition over foreign rent. The latter gap depends positively on the bargaining strength of the unions in the home industry and negatively on the intensity of intra home industry competition.

There is a general result emerging from the two-stage games that we have outlined on export policy. The domestic government has an incentive to tax each unionised firm in a home exporting industry by an amount equal to the wedge driven (by intra home industry competition) between the price cost margin of a home firm under Joint Profit Maximisation to that under free trade. It also has the incentive to subsidise each unionised firm by an amount equal to the wedge driven (due to wage

bargaining) between the wage set in the bargain and the worker's outside option. The policy recommendation depends on how we model the intensity of intra home industry competition over the foreign rent and the bargaining strength of the unions. Intervention ensures that maximum rent (firm and labour) is generated by the home industry in consumerland. In the extreme of perfect intra home industry competition, the socially optimal rent (non-unionised monopoly firm rent) is all captured in the guise of tax revenue. As we relax intra-industry competition, depending on the bargaining strengths of unions and firms, the same industry rent can be taken home in the form of firm and labour rent when a subsidy is deemed optimal or in the form of tax revenue, firm rent and labour rent when a tax is deemed to be the optimal policy.

Proposition 1: The optimal subsidy to a unionised exporting firm in a home industry can be positive or negative. The optimal subsidy depends negatively on the intensity of intra home industry competition and positively on the bargaining strength of unions. Industry output is moved to a level equal to that of a non-unionised monopoly home firm.

The optimal subsidy to the unionised exporting firm in a home industry can be positive or negative. The optimal subsidy is positive when intra-industry competition is weak and unions are strong in the bargaining process. Both these factors make this industry a high wage premium industry. Under these conditions the government has an incentive to increase social surplus by pulling workers into this industry by way of a transfer subsidy payment.

Next we examine *domestic* policy in the presence of unionised intra home industry competition. In (11) we set $K=1$ and solve for the optimal subsidy.

(15) $$s^{o} = (P - c) + (w - A) > 0$$

The optimal subsidy is set to internalise an expected consumption divergence that is negatively related to the intensity of intra-industry competition in the domestic market. It is also set to internalise an expected domestic divergence which is positively related to the bargaining power of unions in the home firms and negatively related to the intensity of intra-industry competition in the domestic market. Substituting s^{o} in (15) into (8), we see that the optimal subsidy gives the home firm an incentive to set employment at the level equal to that which a home firm would set equating P = SMC under conditions of free trade. This maximises the sum of *joint* home firm profits, labour rents and consumer surplus. Industry output is expanded to the socially optimal Bliss point.

There is a general result emerging from the two-stage games that we outlined on domestic policy. The domestic government has an incentive to subsidise each unionised firm in a home industry by its price over cost margin (due to the presence of imperfect intra-industry competition). It also has the incentive to subsidise each unionised firm by an amount equal to the wedge driven (due to wage bargaining) between the wage set in the bargain and the workers outside option. The magnitude of intervention depends on how we model the intensity of intra home industry competition in the domestic market and the bargaining strength of the unions in the home firms. Intervention, with the transfer subsidy payment, ensures that the home industry maximises domestic welfare, even in the presence of imperfect intra-industry competition and wage bargaining. Free trade is only optimal in the limiting case of perfect intra-home industry competition where all union and firm mark-ups are driven to zero.

Proposition 2: In a home industry, under imperfect intra-industry competition, the optimal subsidy to a unionised firm producing for the domestic market is positive. Industry output moves to a level equal to that of a non-unionised competitive industry.

Section II: The New School and Trade Policy

The set of players in this section consists of one unionised home firm, a non-unionised foreign firm and a home government. We abstract from having intra-industry competition between firms from the same country. The home government is modelled to expect both imperfect *international* intra-industry competition and *wage bargaining* over rent and the detrimental effect they have on home welfare. One key element of this analysis is that in formulating export policy, the home government can only impose a policy on the home firm. In this context, the government has a policy choice in the formulation of domestic policy. The government has full information on the nature of the competition between the firms in the industry. It is modelled to anticipate the optimal response of the foreign firm to any action the government may decide to undertake at home and abroad. We examine trade policy where the firms can play either the Cournot or Bertrand Strategy. We first examine trade policy in the presence of unionised international intra-industry competition when the firms in the industry play the Cournot strategy.

Both firms are assumed to play the Cournot strategy. The home and foreign firm produce a homogeneous product with one factor of production, labour. A home firm produces X with a simple technology $X = L$ and earns a payoff π. A foreign firm produces Y with a simple technology $Y = L^*$ and earns a payoff π^*. The inverse demand curve is assumed to be following:

(16) $$P = 1 - Q, \quad Q = X + Y, \quad P'(Q) < 0$$

The payoff to the home firm is written as in (2). Let $c^* = (w^* + r)$ be the foreign firm's unit variable cost, where w^* is the foreign firm's unit wage cost. For simplicity we set it equal to zero. r is the per unit tariff that can be levied on the foreign firm in the domestic market. The foreign fixed cost of production is assumed to be zero. The payoff to a foreign firm is the following:

(17) $$\pi^* = (P(Q) - c^*)L^*$$

Let $A = 0$, the outside option for the home firm workers. The union in the home firm maximises the payoff in (3). The government is assumed to give equal weighting to all components of the following welfare function in evaluating welfare.

(18) $$G = \pi + (w-A)L - sL + rY + KV(P,b)$$

The government sets $K = r = 0$ when evaluating export policy. In domestic policy decision making we set $K = 1$. The government evaluates both the optimality of a subsidy (setting $r = 0$) and tariff (setting $s = 0$) in formulating domestic policy.

The government moves first in all policy decisions. It is assumed to understand the dependence of the second stage on the first. This will lead to a Nash equilibrium in each subgame. Hence, we consider the second stage first.

In the *second stage*, the home firm bargains with its union over the wage level only. Simultaneously to the wage bargaining process, the firms in the industry set their

employment levels. To model *wage setting* in the home firm we use the same (generalised) asymmetric Nash bargaining solution as in section I. We express the generalised Nash product as in (6). To get the Nash bargaining solution we maximise (6) with respect to w, given s, holding Q constant. The first order condition is expressed as in (7). This may be re-expressed as the following optimal response function.

(19) $$w = R^{\cdot}(L, L^{*})$$

Employment setting in the home firm is modelled simultaneously to the bargaining process. A home firm chooses L to maximise π, given s, holding w and L^* constant. We write down the first order condition for a home firm as in (8) and re-express it as the following optimal response function.

(20) $$L = R^{\cdot}(w, L^{*})$$

(9) implies the uniqueness and stability of the home wage and employment setting equilibrium. *Employment setting* in the foreign firm is modelled simultaneously to the bargaining process and employment setting in the home firm. A foreign firm chooses L^* to maximise π^*, given r, holding L constant. The foreign firm's first order condition can be re-expressed as the optimal response function $L^* = R^*(L)$.

(21) $$\pi^*_{L^*} = P + L^*P' - c^* = 0, \qquad \pi^*_{L^*L^*} < 0$$

The principal minors of the following determinant alternate in sign, starting negative,

and ensure the uniqueness and stability of the Nash equilibrium:

$$(22) \qquad D = \begin{vmatrix} \pi_{LL} & \pi_{Lw} & \pi_{LL^*} \\ \Omega_{wL} & \Omega_{ww} & \Omega_{wL^*} \\ \pi^*_{L^*L} & \pi^*_{L^*w} & \pi^*_{L^*L^*} \end{vmatrix} < 0$$

The solution functions for the wage and employment levels are derived from the optimal response functions (19), (20) and (21)[6]. We find the comparative static effects of a change in s and r. We express them as the following:

$$(23) \qquad L^o(\beta, s, r), \qquad L_s = 2(1-\beta)/(3-\beta) > 0 \quad L_r = (1-\beta)/(3-\beta) > 0$$

$$w^o(\beta, s, r), \qquad w_s = 2\beta/(3-\beta) > 0 \quad w_r = \beta/(3-\beta) > 0$$

$$L^{*o}(\beta, s, r), \qquad L^*_s = -(1-\beta)/(3-\beta) < 0 \quad L^*_r = -(1+(1-\beta))/(3-\beta) > 0$$

First we examine *export* policy. In the *first stage* the domestic government chooses s to maximise (18) in anticipation of the nature of competition in stage two. Using Roy's Identity, setting the marginal utility of income equal to one and $K = r = 0$, we write down the first order condition for the government as the following:

$$(24) \qquad G_s = \pi_s + (w-A)L_s + Lw_s - sL_s - L = 0$$

Making use of the envelope theorem, we note that $\pi_s = LP'L^*_s - Lw_s + L$. Taking a total differential of (17) while holding c^* constant implies that $dL^*/dL = -\pi^*_{LL^*}/\pi^*_{L^*L^*} = L^*_s/L_s$

[6] The solution functions for the employment levels will be useful in later examples to calculate industry output Q in alternative regimes. $L=((1-\beta)(1+2s+r))/(3-\beta)$ and $L^*=(1-r(1+(1-\beta))-s(1-\beta))/(3-\beta)$.

< 0. We solve for the optimal subsidy from (29) as the following:

(25) $$s^o = LP'dL^*/dL + (w - A) = (SMR - PMR) + (SMC - PMC) > 0$$

The optimal subsidy is signed using (16) and (19). The optimal subsidy in (25) induces the home firm to produce an output level that corresponds to an output level set if it had the benefit of first mover advantage (hence anticipating the optimal response function of the foreign firm) *and* had included labour rent in its payoff function. With a first mover advantage, the home government anticipates a trade divergence. The home government expects that the foreign firm would decrease its output and partially offset the fall in the industry price if the home firm expanded its output. This would offset the revenue lost on inframarginal sales. The government is looking at the game from this point of view. From a social perspective, the government expects the home firm to *overestimate* the loss on inframarginal sales when it produces output in the simultaneous move equilibrium[7]. This is what drives the wedge between the SMR and the PMR in home production. In Corden's terminology, this leads to the government's anticipation of a trade divergence. The domestic divergence is created by the presence of wage bargaining in the home firm. In the presence of wage bargaining the home government anticipates that the home firm will treat the rent component of its wage bill as a cost. From a social perspective, the government expects the home firm to *overestimate* the marginal cost of producing in the simultaneous move equilibrium. This is what drives the wedge between the SMC and the PMC of home production.

[7] In the phraseology of Bulow et al (1985) output levels in this game are strategic substitutes.

The motive for the subsidy is rent (firm and labour) creation. The government creates rent by exploiting the price support offered by the foreign firm and by pulling workers into a home firm that pays a wage premium[8]. What determines the magnitude of the subsidy in the above model? First, the more profitable the home firm in the simultaneous move equilibrium, the more the government can exploit the *partial price support* that is being offered by the foreign firm to increase the rent (firm and labour) generated in the home firm. Secondly, the wage mark-up is bigger, the more profitable the home firm and the greater the bargaining power of the union. The subsidy promotes an expansion of employment in a high wage premium industry. The bigger the wage premium, the greater the social benefit (in terms of labour rent creation) of pulling employment into a high wage firm. The government anticipates a bigger welfare gain from intervention the more *profitable* the unionised home firm and the more powerful the union in the bargaining process. Hence, it commits itself to a bigger transfer payment.

Proposition 3: A home government has a unilateral incentive to offer a subsidy to a unionised exporting firm under international Cournot competition. The optimal subsidy is increasing in the profitability of the home firm and increasing in the bargaining strength of the union.

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[8] Brander and Spencer (1988) were the first to analyse trade policy under international Cournot competition. They make the proposition that, compared to their non-unionised model in (1985), the optimal subsidy is always greater in the presence of a union. They feel that a bigger subsidy is required under unionisation since the union taxes a profit shifting process. We feel that the subsidy is bigger because there is a labour rent creation motive for trade policy in addition to the normal firm rent motive for intervention.

Next we examine *domestic* policy. The government has a choice of policy instruments when a foreign firm operates in an industry that produces for the domestic market. We first derive the expression for the optimal subsidy. In the *first stage* the domestic government chooses s to maximise (18) in anticipation of the nature of the competition in stage two. Using Roy's Identity, setting the marginal utility of income equal to one and r = 0, we write down the first order condition for the government.

(26) $$G_s = \pi_s + (w\text{-}A)L_s + Lw_s - sL_s - L - QP_s = 0$$

Making use of the envelope theorem, solve for the optimal subsidy from (26) and re-express it using (19), (20) and (23):

(27) $$s^o = (P - c) + (w - A) + 1/2(P - c^*) = 1/(1-\beta) > 0$$

The optimal subsidy in (27) induces the industry to produce that which would be the output of a perfectly competitive non-unionised industry. In our model, if the home firm sets price equal to social marginal cost and the foreign firm also sets price equal to marginal cost, the socially optimal industry output is $Q^* = 1$ (using (16) and noting $w^* = A = 0$). Under conditions of free trade the industry output, $Q^{FT} = (2-\beta)/(3-\beta)$, is less than two-thirds of the output needed to reach the socially optimal output. The monopoly power of the firms creates a consumption divergence and the presence of wage bargaining creates a domestic divergence in the domestic market. The subsidy in (27) is big enough to ensure that the industry price collapses to zero (First, substitute s^o in (27) into the employment solutions in footnote 6 and substitute the resulting solutions

into (16) to find that P = 0). This takes account of the foreign firm's optimal response to the subsidy. The foreign firm will contract output in response and as a result partially holds up the industry price. The transfer subsidy payment to the home firm to internalise both the consumption and domestic divergence must be much bigger than the subsidy in the old school to bring industry output up to the socially optimal point in the presence of international competition.

Proposition 4: A home government has a unilateral incentive to offer a subsidy to a unionised home firm operating in the domestic market under international Cournot competition. Even in the presence of international competition, this pushes industry output to a level equal to that of a competitive non-unionised industry.

Next, we derive the expression for the optimal tariff when the firms are operating in the domestic market. In the *first stage*, the domestic government chooses r to maximise (18) in anticipation of the nature of competition in stage two. Using Roy's Identity, setting the marginal utility of income equal to one and s = 0, we write down the first order condition for the government as the following:

$$(28) \qquad G_r = \pi_r + (w\text{-}A)L_r + Lw_r + Y + rY_r - QP_r = 0$$

Making use of the envelope theorem, we note that $\pi_r = LP'L^*_r - Lw_r$. We solve for the optimal tariff as the following and re-express it using (19), (20) (21) and (23):

$$(29) \qquad r^o = (P - c^*) + (P - c)(1/(1+(1-\beta)) = (3-2\beta)/((3-2\beta)^2+4\beta) > 0$$

The optimal tariff in (29) induces the industry to produce at the output level of a non-unionised monopoly firm (substitute r^o in (29) into the employment solutions in footnote 6). When the marginal cost of production is zero for a monopoly firm, given the demand conditions in (16), the monopoly output is $Q^M = 1/2$. The tariff in (29) creates monopoly rent for the home country in the guise of home firm rent, labour rent and tax revenue. The cost of this is to create a consumption divergence that a non-unionised monopoly firm would create if it was operating in the domestic market. The optimal tariff equates the marginal production and revenue gain of a tariff to the marginal consumption loss. This happens when industry output is cut back to the output of a non-unionised monopoly firm. In moving towards this output, the loss in consumer surplus does not outweigh the gain in home firm rent, labour rent and tax revenue. In the equilibrium, the optimal tariff appropriates all the monopoly rent to the home country. This creates a higher level of welfare compared to that created in the free trade equilibrium. Compared to the subsidy, it is a second best policy instrument since it does not bring industry output to the socially optimal Bliss point. On the contrary, it moves industry output in the other direction.

Proposition 5: A home government has a unilateral incentive to levy a tariff on a foreign firm operating in the domestic market under international Cournot competition. This pushes industry output to a level equal to that of a non-unionised monopoly firm and appropriates this monopoly rent to the home country.

In figure 2:1, we examine domestic policy within the above framework using a simple numerical example. The unionised home firm and the non-unionised foreign firm

sell into the domestic market facing the domestic demand conditions D as in (16). The industry P is on the vertical axis and the industry output Q is on the horizontal axis. In free trade equilibrium, the industry output is equal to $Q^{FT} = 0.6$ for $\beta = 0.5$. This induces an industry price P^{FT}. The unionised home firm produces $X_0 = 0.2$ and the non-unionised foreign firm produces $Y = 0.4$ in the free trade equilibrium. The loss in consumer welfare due to the monopoly power of the firms is given by the area $0P^{FT}AQ^*$. This is partially offset by the existence of home firm rent and labour rent given by the area $0P^{FT}BX_0$. The wedge driven by the bargaining process between the private and social marginal cost of producing is given by (w - A).

The optimal subsidy in (27) ensures that the industry price collapses to zero. Even in the presence of unionised international intra-industry competition the optimal subsidy induces firms to produce that which would be the output of a perfectly competitive non-unionised home industry $Q^* = 1$.

The optimal tariff induces the industry to produce that which would be the output of a non-unionised monopoly firm $Q^M = 1/2$. The optimal tariff in (29) causes home output to rise from $X_0 = 0.2$ to $X_1 = 0.25$. It causes foreign output to fall from $Y_0 = 0.6$ to $Y_1 = 0.25$. This leads to a fall in consumer welfare by the area $P^{FT}P^MCA$. It increases home welfare by increasing home firm and labour rent by the area $P^{FT}P^MDX_1X_0B$. This is one half of the monopoly rent. The foreign firm's share in the monopoly rent is appropriated to the home country in the form of tax revenue. This is given by the area X_1DCQ^M. At $Q^M = 1/2$, the marginal production gain and revenue of a tariff just equals the marginal consumption loss. The optimal tariff appropriates all of the monopoly rent to the home country. This induces a higher level of welfare compared to that which would result in the free trade equilibrium. Compared to the subsidy, it is a second best

policy instrument since it does not bring industry output to the socially optimal Bliss point. We now turn to the analysis of unionised international Bertrand competition to show that the general results that emerge from the above analysis are robust to having both firms playing the Bertrand strategy.

We assume that the home and the foreign firm produce imperfect substitutes with one factor of production, labour. The home firm produces X with a simple technology X = L, at a price P and earns a payoff π. The foreign firm produces Y with a simple technology $Y = L^*$, at a price P^* and earns a payoff π^*. The demand conditions are same as those derived in Singh and Vives's (1984) duopoly model of product differentiation.

(30)
$$X(P, P^*) = 1 - a_0P + a_1P^*, \qquad 0 < a_0 < 1$$
$$0 < a_1 < 1$$
$$Y(P, P^*) = 1 - a_0P^* + a_1P, \qquad a_0 > a_1$$

Let c = (w-s) be the unit wage cost net of the per unit subsidy. We write the payoff to the home firm as:

(31)
$$\pi = (P - c)x(P, P^*)$$

Let $c^* = (w^* + r)$. We set the unit wage cost of production $w^* = 0$. r is the per unit tariff that is levied on the foreign firm. We write the payoff to a foreign firm as:

(32)
$$\pi^* = (P^* - c^*)y(P, P^*)$$

The payoff to the union, the payoff to the home government and the set-up of the two-stage games are the same as those outlined under unionised international Cournot competition. To model *wage setting* we maximise (6) with respect to w, given s, holding P and P^* constant. The first order condition is expressed as (7) and is re-expressed as the following optimal response function.

(33) $$w = R^{\cdot}(P, P^*)$$

Price setting in the home firm is modelled simultaneously to the bargaining process. A home firm chooses P to maximise π, given s, holding w and P^* constant. We write down the first condition for the home firm and re-express it as the optimal response function $P = R^{\cdot}(w, P^*)$.

(34) $$\pi_p = (P - c)x_p + x = 0, \qquad \pi_{pp} < 0$$

The following holds and ensures uniqueness and stability of the home wage and price setting equilibrium,

(35) $$D = \Omega_{ww}\pi_{PP} - \Omega_{wP}\pi_{Pw} > 0$$

Price setting in the foreign firm is modelled simultaneously to the bargaining process and price setting in the home firm. A foreign firm chooses P^* to maximise π^*, given c^*, holding P constant. The foreign firm's first order condition is re-expressed as the optimal response function $P^* = R^*(P)$

(36) $$\pi^*_{p^*} = (P^* - c^*)y_{p^*} + y = 0, \qquad \pi^*_{p^*p^*} < 0$$

The principal minors of the following determinant alternate in sign, starting negative, to ensure uniqueness and stability of the Nash equilibrium:

(37) $$D = \begin{vmatrix} \pi_{PP} & \pi_{Pw} & \pi_{PP^*} \\ \Omega_{wP} & \Omega_{ww} & \Omega_{wP^*} \\ \pi^*_{P^*P} & \pi^*_{P^*w} & \pi^*_{P^*P^*} \end{vmatrix} < 0$$

The solutions for the wage and price levels are derived from the optimal response functions (33), (34) and (36)[9]. We find the comparative static effects of a change in s and r. We express them as the following:

(38) $$P^o(\beta, s, r), \quad P_s = 2a_0(1-\beta)/D < 0 \quad P_r = -a_0a_1/D > 0$$

$$w^o(\beta, s, r), \quad w_s = -(2\beta a_0 - \beta a_1^2)/D > 0 \quad w_r = -\beta a_0 a_1/D > 0$$

$$P^{*o}(\beta, s, r), \quad P^*_s = a_1(1-\beta)/D < 0 \quad P^*_r = -a_0(2-\beta)/D > 0$$

We first examine *export* policy. In the *first stage* the domestic government chooses s to maximise (18) in anticipation of the nature of competition in stage two. Using Roy's Identity, setting the marginal utility of income equal to one and $K = r = 0$, we write down the first order condition for the government as in (24). Making use of the envelope theorem, we note that $\pi_s = (P - c)x_{p^*}P^*_s - Lw_s + L$. We solve for the optimal subsidy as the following:

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[9] The solution functions for the price levels will be useful in later examples to calculate industry output Q in alternative regimes. $P = (2a_0s(1-\beta)-2-a_1-a_0a_1r)/D$ and $P^* = (\beta-2-(a_0/a_1)+a_1s(1-\beta)-2a_0r+a_1\beta r)/D$.

(39) $$s^O = -(P - c)(a_1^2/(2a_0^2-a_1^2)) + (w - A) = (SMR - PMR) + (SMC - PMC)$$

The optimal subsidy in (39) induces the home firm to produce the same level of output that it would produce if it had the benefit of first mover advantage (thus anticipating the optimal response function of the foreign firm) and *also* had included labour rent in its payoff function. The trade divergence is created by giving the home government a first mover advantage. With first mover advantage, the home government anticipates that the foreign firm will price follow in response to any price the home firm sets. This would increase the revenue lost on inframarginal sales. The government is looking at the game with this point of view. From a social perspective, the government expects the home firm to *underestimate* the loss on inframarginal sales when it produces output in the simultaneous move equilibrium[10]. This is what drives the wedge between the SMR and the PMR in home production.

The domestic divergence is created by the presence of wage bargaining in the home firm. In the presence of wage bargaining the home, government anticipates that the home firm will treat the rent component of the wage bill as a cost. From a social perspective, the government expects the home firm will to *overestimate* the marginal cost of producing in the simultaneous move equilibrium. This is what drives the wedge between the SMC and the PMC of home production.

The motive for the subsidy is rent (firm and labour) creation. With a tax, the government can increase home firm rent by exploiting the price following offered by the foreign firm. With a subsidy, the government can increase labour rent by expanding

[10] In the phraseology of Bulow et al (1985) output levels in this game are strategic complements.

employment in a firm that pays a wage premium to its workers. The sign of the optimal subsidy depends on the degree of product differentiation and union bargaining power that we impose in our model. We can rewrite (39) as the following:

$$(40) \qquad s^0 = (w - A)(2\beta a_0^2 - a_1^2)/\beta(2a_0^2 - a_1^2)$$

In the upper limit of product differentiation, any union bargaining power will be sufficient to make the subsidy positive. In the lower limit of product differentiation, the union must have more bargaining power than the home firm, if the subsidy is to be optimal. There is always a value for β which ensures that the optimal subsidy is positive. The more differentiated the home firm's product, the lower value of β is needed to make the optimal subsidy positive.

What determines the magnitude of the subsidy in the above model? The subsidy is increasing in the degree of product differentiation in the presence of wage bargaining. It is also increasing in the bargaining power of the union in the wage bargain. Both these factors lead to a bigger wage mark-up. The more profitable the home firm in the simultaneous move equilibrium and the more powerful the union in the bargaining process, the more labour rent that can be created by expanding employment with a subsidy. Hence the government anticipates a *net* welfare gain from intervention due to an increase in labour rent. It is prepared to forgo the opportunity to exploit the price following offered by the foreign firm. It commits itself to a transfer subsidy payment that pulls labour into a firm paying a wage premium.

Proposition 6: The optimal subsidy to a unionised exporting firm under international Bertrand competition can be positive or negative. The optimal subsidy is increasing in the profitability of the home firm and increasing in the bargaining strength of the union.

Next we examine *domestic* policy. The government has a choice of policy instruments when there is international competition in the domestic market. First, we first derive the expression for the optimal subsidy. In the *first stage* the domestic government chooses s to maximise (18) in anticipation of the nature of competition in stage two. Using Roy's Identity, setting the marginal utility of income equal to one and r = 0, we write down the first order condition for the government.

$$G_s = \pi_s + (w - A)L_s + Lw_s - sL_s - L - XP_s - YP^*_s = 0 \tag{41}$$

Making use of the envelope theorem we solve for the optimal subsidy from (41) and re-express it using (38) and (41).

$$s^o = (P - c) + (w - A) + (P - c^*)(a_0a_1/(2a_0-a_1^2)) > 0 \tag{42}$$

The optimal subsidy in (42) induces the industry to produce at the socially optimal Bliss point. In our model if the home firm sets price equal to social marginal cost and the foreign firm also sets price equal to marginal cost then $P = P^* = 0$. Given the demand conditions in (30), the industry Bliss output is $Q^* = 2$. Under conditions of free trade the industry output Q^{FT} is below the output needed to reach the socially optimal output. The monopoly power of the firms creates a consumption divergence and

the presence of wage bargaining creates a domestic divergence in the domestic market. The subsidy in (42) is big enough to ensure that the industry price, *on average*, collapses to zero. This takes account of the foreign firm's optimal response to the subsidy.

Proposition 7: A home government has a unilateral incentive to offer a subsidy to a unionised home firm operating in the domestic market under international Bertrand competition. Even in the presence of international competition, this pushes industry output to the socially optimal Bliss point.

Next we derive the expression for the optimal tariff when the firms are operating in the domestic market. In the *first stage* the domestic government chooses r to maximise (18) in anticipation of the nature of competition in stage two. Using Roy's Identity, setting the marginal utility of income equal to one and s = 0, we write down the first order condition for the government as the following:

$$G_r = \pi_r + (w\text{-}A)L_r + Lw_r + Y + rY_r - XP_r - YP^*_r = 0 \tag{43}$$

Making use of the envelope theorem, we note that $\pi_r = (P- c)X_{P*}P^*_r - Lw_r$. We solve for the optimal tariff and establish its sign using (30),(38) and (43).

$$r^o = (P - c^*) + P\theta > 0, \qquad \theta = (2-\beta-a_0)/((2-\beta)(a_0/a_1)-a_1) \tag{44}$$

The optimal tariff in (44) induces the industry to produce that which would be the output of a non-unionised monopoly firm producing both products. When the social

marginal cost of production is zero for the monopoly firm, the monopoly output, given the symmetric demand conditions in (30), is X = 0.5 and Y = 0.5. The tariff in (44) creates monopoly rents for the home country in the form of home firm rent, labour rent and tax revenue, leading to a deterioration in domestic consumer surplus. The optimal tariff equates the marginal production and revenue gain of a tariff to the marginal consumption loss. This happens when industry output is cut back to the output of a non-unionised monopoly firm operating in the domestic market.

Proposition 8: *A home government has a unilateral incentive to levy a tariff on a foreign firm operating in the domestic market under international Bertrand competition. This pushes industry output to a level equal to that of a non-unionised monopoly firm operating in the domestic market and appropriates this monopoly rent to the home country.*

In figures 2:2 and 2:3, we examine domestic policy within the above framework using a simple numerical example. Throughout the example in our demand conditions in (30) we set $a_0 = 0.9$, $a_1 = 0.5$. We also set $\beta = 0.5$ and work with the solution functions in footnote 9. In Figures 2:2b and 2:3b, the unionised home firm faces the demand curve $D(P_0^*)$ in the free trade equilibrium and produces at $X_0 = 0.5$. The home firm's rent is given by the area WP_oAB and labour rent is given by the area $0WBX_0$. In figure 2:2a and 2:3a the non-unionised foreign firm sells into the domestic market facing the domestic demand curve $D(P_0)$ and produces at $Y_0 = 0.8$. The foreign firm's rent is given by the area $0P^*_0CY_0$. The loss in consumer welfare due to the monopoly power of the firms is given by the areas $Y_0CY^* + X_0AX^*$.

In figure 2:2a and 2:2b, the optimal subsidy ensures that, on average, the prices of the two goods are zero. This induces the firms to produce (even in the presence of unionised international intra-industry) that which would be the output of a non-unionised industry in which firms priced equal to marginal cost. Thus for the two products, $Q^* = 2$. Given the optimal subsidy in (42), the home firm faces a new demand curve $D(P^*_1)$ and produces where $X_1 = 1.2$. There is a greater inward shift in the demand curve faced by the foreign firm. The foreign firm now faces $D(P_1)$. It produces at $Y_1 = 0.8$. The net gain in welfare is given by the shaded areas $(P^*_1P^*_0D + X_0EF) - (GAE + FHX_1)$.

The optimal tariff in (44) induces the industry to produce that which would be the output of a non-unionised monopoly producing both products in the domestic market, $X = 0.5$ and $Y = 0.5$. The optimal tariff induces the home firm to produce $X_1 = 0.5$ and the foreign firm to produce $Y_1 = 0.5$ (see figure 2:3a and 2:3b). The demand curve for both goods shifts out. The foreign firm's demand curve shifts by greater amount compared to the home firm. The tariff increases home welfare by increasing home firm and labour rent. The foreign firm's share in the monopoly rent is also appropriated to the home country in the form of tax revenue. The tariff decreases consumer welfare. The net welfare gain is given by the shaded areas $(0P^*_0EY_1) - (EFY^{**}Y^*CE + ADX^{**}X^*)$. At $X = Y = 0.5$, the marginal production and revenue gain of a tariff just equals the marginal consumption loss. This equilibrium induces a higher welfare gain compared to that which would occur in the free trade equilibrium. Compared to the subsidy, it is a second best policy instrument as it does not bring industry output to the socially optimal Bliss point.

Conclusion

We have examined trade policy in the presence of a unionised international competition. The presence of union in a home exporting firm ensures that the home firm's wage bill includes a rent component. This social benefit of production should be included in social surplus as rent generated within an industry. We examine *export* policy in the absence and in the presence of international competition. In both cases, the optimal subsidy to an exporting home firm is negatively related to the intensity of intra-industry competition it faces and positively related to the bargaining strength of its union. The optimal subsidy is always positive when unionised intra-industry competition is weak and when union bargaining power is strong. Both of these conditions ensure that workers in the home exporting firm earn a high wage premium. This gives the home government a labour rent creation motive for trade policy. The government can increase social surplus by promoting the expansion of employment in high wage premium exporting firms. The more profitable the home exporting firm (due to weak intra-industry competition) and the more powerful the union in the wage bargaining process the more it can increase social welfare by pulling employment into high wage premium exporting firms.

We also examined domestic policy in the absence and in the presence of international competition. Both a subsidy payment to a home firm or a tariff levy on a foreign firm are considered to be optimal policies. In the presence of imperfect intra-industry competition and wage bargaining, the best policy is always a subsidy payment to the home firm. The optimal subsidy would always bring industry output (even in the presence of unionised international intra-industry competition) to the socially optimal Bliss point. The tariff is a second best policy in the presence of unionised international

intra-industry competition. The optimal tariff moves industry output to a level corresponding to that of a non-unionised monopoly firm operating in the domestic market. The optimal tariff appropriates the rent of a non-unionised monopoly to the home country in the guise of increased home firm rent, labour rent and tax revenue. The cost of this is a decrease in consumer surplus. In the presence of imperfect unionised international intra-industry competition, the appropriation of the monopoly rent to the home country using the optimal tariff, is a preferred option to free trade. The consumer gain under free trade does not compensate for the fall in home firm rent, labour rent and tax revenue. From society's point of view, free trade is the third best outcome. It allows foreign firms to exploit consumers and earn rent that is of no value to the home country.

FIGURE 2:1

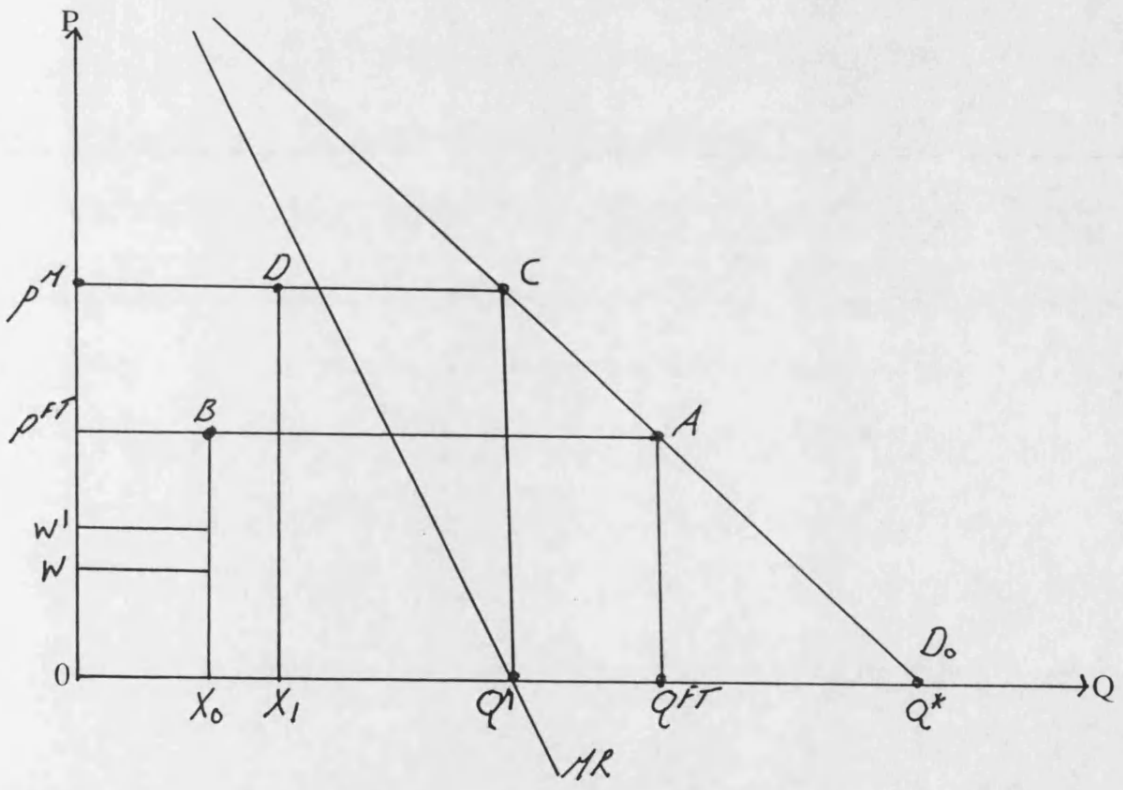


FIGURE 2:2a

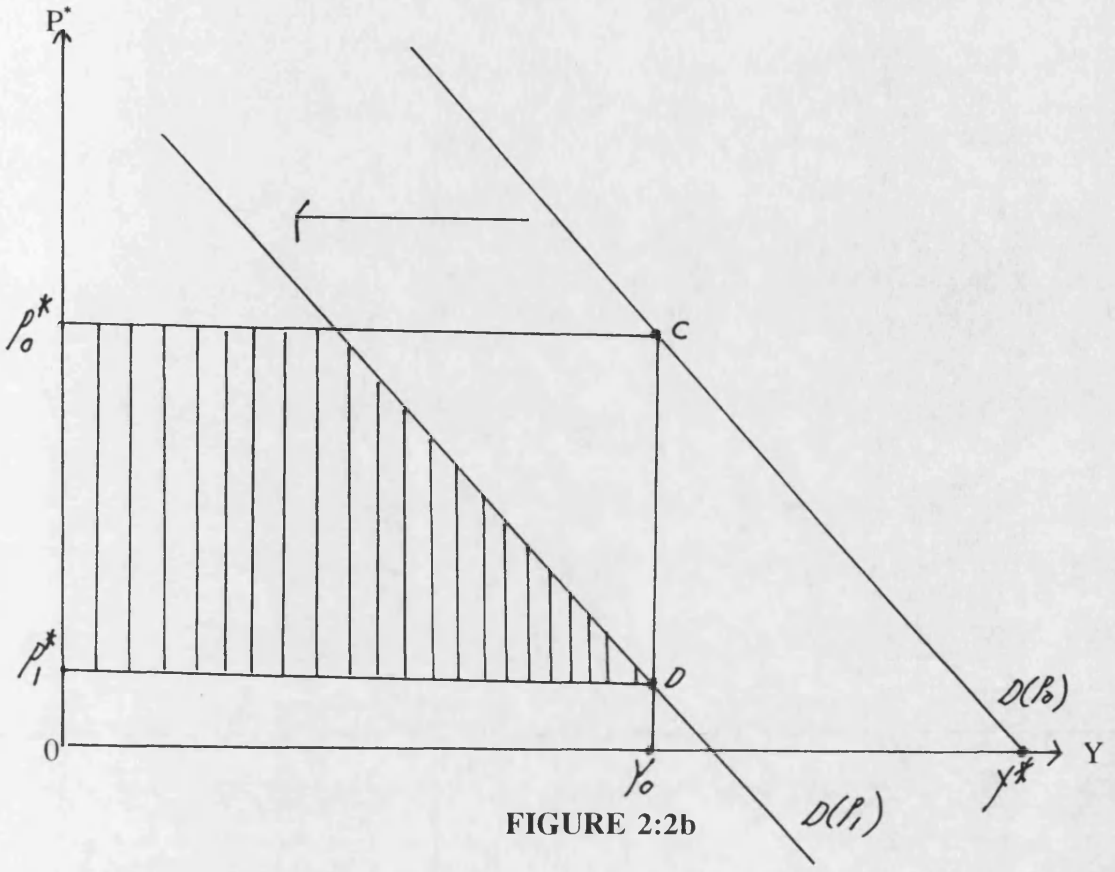


FIGURE 2:2b

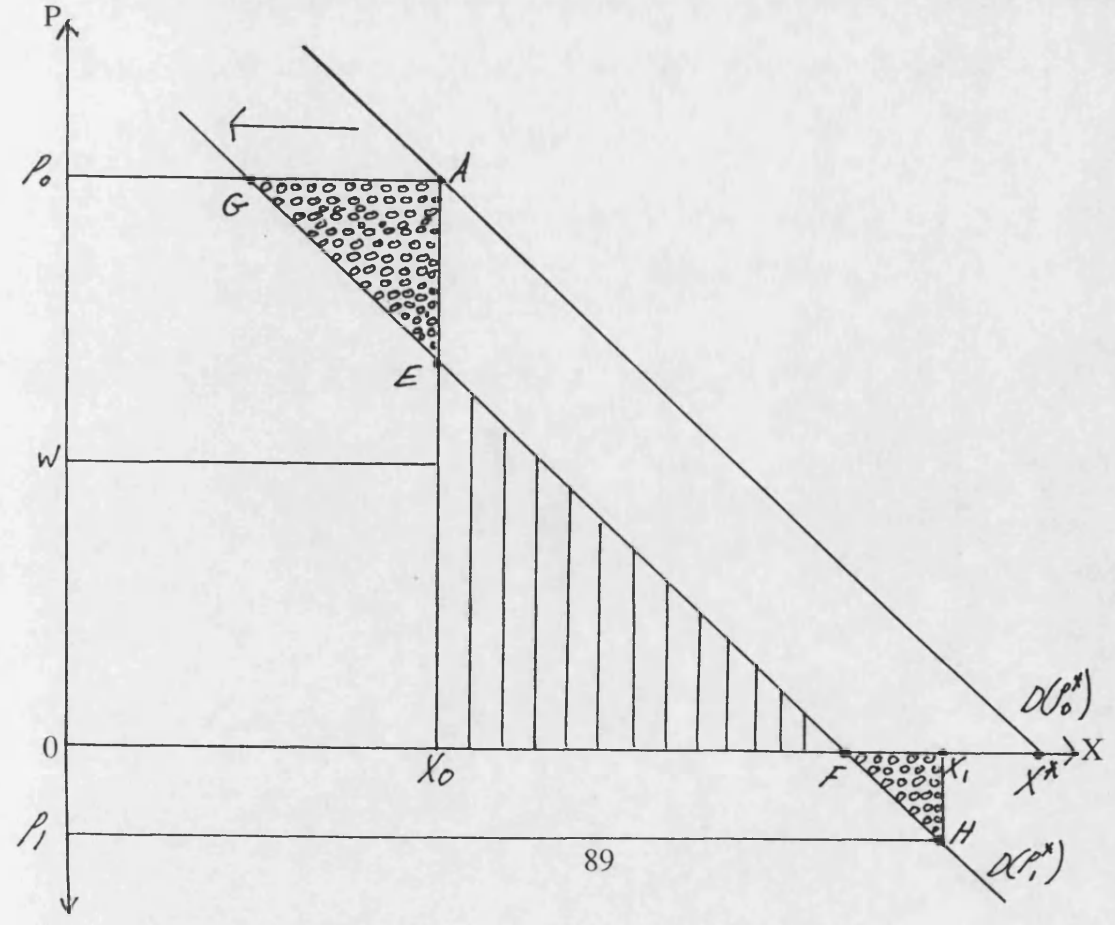


FIGURE 2:3a

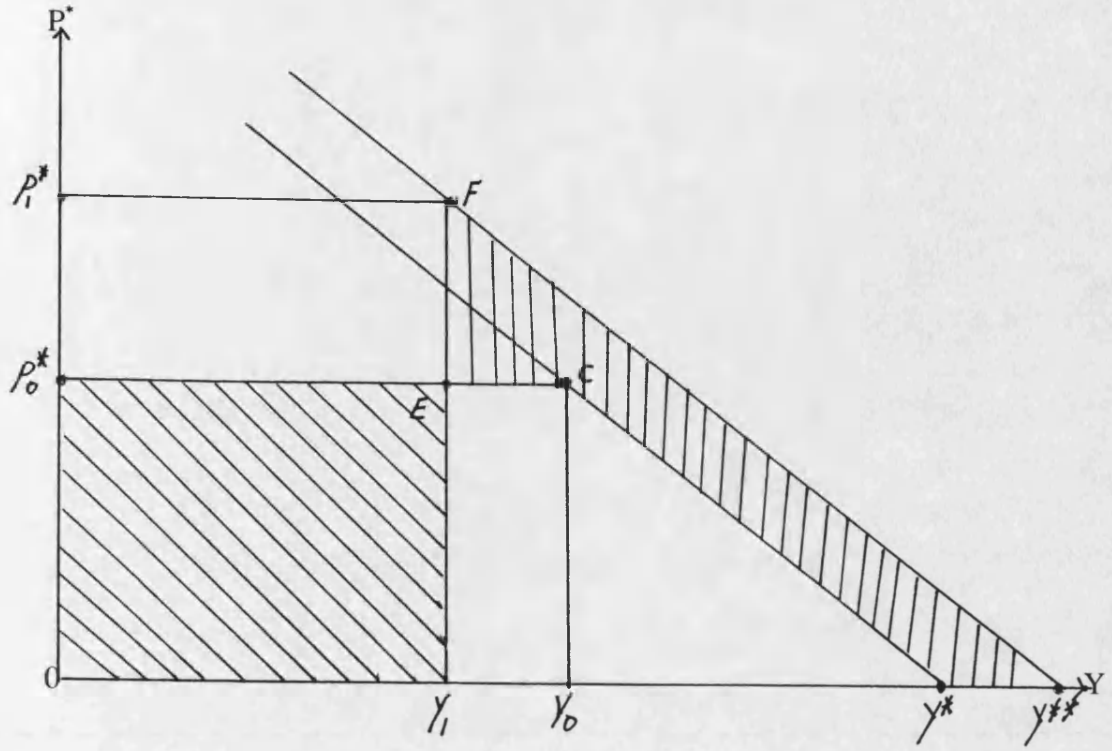
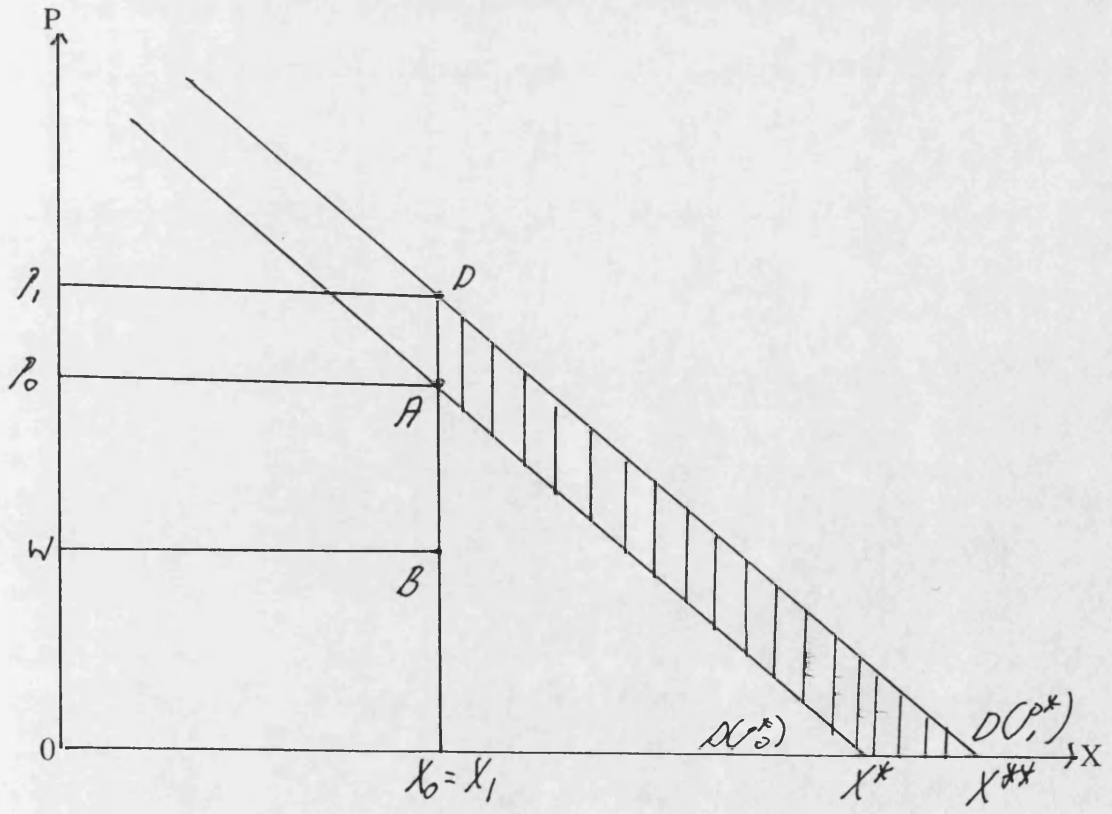


FIGURE 2:3b



CHAPTER 3

INTRA-INDUSTRY COMPETITION, EFFICIENCY WAGES AND EXPORT POLICY

INTRODUCTION

In this chapter we examine export policy in the presence of imperfect intra-industry competition and efficiency wage payments. We analyse the *old school* and export policy in section I. Only home firms operate in a foreign market, which we call "consumerland". The home government is modelled to anticipate both a trade and a domestic divergence in the free trade equilibrium. A trade divergence results from the government's anticipation of intra home industry competition over rent in consumerland and the detrimental effect it has on home welfare. The government anticipates that under conditions of free trade, the home industry would fail to take home the monopoly rent from consumerland. A domestic divergence results from the government's anticipation of efficiency wage payments and the detrimental effect it has on welfare. The government anticipates that home firms will not treat the rent component of a wage bill as a social benefit of production. Following Sah and Stiglitz (1985), we include it in social surplus since as rent generated within the industry. The government anticipates that, in the free trade equilibrium, maximum industry rent (including labour rent) will not be captured by the home country industry. In anticipation of this the government undertakes measures to rectify this. The optimal subsidy per unit of output to an exporting firm paying efficiency wages can be positive or negative. The optimal subsidy is positive when the home government expects that intra-industry competition is weak and the wage premium workers receive for efficiency wage reasons is high. Under these conditions the government has an incentive to increase social surplus by pulling workers into this high wage premium industry, even though this will lead to a deterioration in the terms of trade. This ensures that the home industry produces the output equal to that of an industry where the home firms objective is to maximise *joint* home firm *and*

labour rents.

The focus of section I then changes to examine the social benefit of a subsidy per unit of *labour* to a home exporting firm. Katz and Summers (1989) were the first to examine this issue. Labour market rents in the U.S. are shown to dwarf product market rents. Industries in which most firms are net exporters are shown to carry more labour rent than those industries in which most firms are net importers. They make a welfare argument that a labour subsidy should be to given to "sunrise" exporting industries as a policy to encourage employment in the high wage premium sector. Their argument depends on the assumption that the worker's ability to extract rents is increased when the demand for labour increases. This is not the case in our generalised efficiency wage model. We show that in response to a labour subsidy, the wage premium offered by the firm declines. The optimal labour subsidy has no effect on the output produced by home firms. The same output is produced with more labour and less effort. Product market rent remains unchanged. Labour rent also remains unchanged. Even though home firms are more labour intensive, the wage premium falls and ensures that overall the rent component of the wage bill is unchanged. This suggests that a labour subsidy that pulls employment into "sunrise" exporting firms does not increase welfare. There is no labour (or product market) rent creation motive for a labour subsidy in our framework.

We analyse the *new school* and export policy in section II. The industry in this section consists of one home firm that pays efficiency wages and a foreign firm that pays its workers an outside option. We abstract from having intra-industry competition between firms from the same country. We model the home government to expect both a trade and a domestic divergence in the free trade equilibrium. A trade divergence

results from the government's anticipation of international intra-industry competition and the detrimental effect it has on home welfare. A domestic divergence results from the government's anticipation of the detrimental effect efficiency wage payments have on welfare. One key element of this analysis is that the home government can only impose a policy on the home firm. The response of the foreign firm to government action is an important factor that determines policy. We examine export policy where the firms play either the Cournot or Bertrand Strategy. The optimal subsidy per unit of *output* to the exporting firm facing international Cournot competition and paying efficiency wages is positive. The optimal subsidy under international Bertrand competition in the presence of efficiency wages payments can be positive or negative. In both cases, as in the old school, the optimal subsidy is positive when the government anticipates that international intra-industry competition is weak and the wage premium for home workers is high. Under these conditions, the government has an incentive to increase social surplus by pulling workers into an exporting firm that pays a wage premium. Under these conditions there is a labour rent creation motive for export policy.

Section I: The Old School and Export Policy

Efficiency wage theories in recent years have been put forward as attractive ways of explaining involuntary unemployment and other aspects of the labour market. Solow's (1979b) efficiency wage model captures the essence of the efficiency wage argument. Its results can be generalised to all efficiency wage models[1]. The key feature is that the wage has a dual function. One function is to hire labour and the other is to create

[1] There are five important efficiency wage models that explain why firms find it *profitable* to pay wages above the opportunity cost of labour: The Shirking Model (Shapiro and Stiglitz 1984), The Labour Turnover Model (Salop 1979), The Adverse Selection Model (Weiss 1980), The Sociological Models (Akerlof 1984) and The Union Threat Model (Dickens 1986).

incentives that reduce efficiency costs. Wage premiums are paid to create incentives that are cost reducing or productivity enhancing. This can be done in many ways, as explained by the existing theories of efficiency wages. Rent sharing under efficiency wage payments is a fundamentally different type of rent sharing to that under wage bargaining. The wage premium that results from an efficiency wage payment is only a fraction of the product market rent it creates. This is a share in *additional rent* created by the wage premium itself rather than a share in the *absolute rent* created by the firm. The firm would not commit to paying wage premium incentives if there was no net gain in the product market from doing so. This feature is common to all efficiency wage theories. We model the labour market by embedding Solow's (1979b) efficiency wage model into the oligopoly framework. This model captures the essence of the efficiency wage argument, that is present in all efficiency wage models. Hence we interpret the model as a general efficiency wage model.

The set of players in this section consists of N home firms paying efficiency wages and a domestic government. The N identical home firms produce a homogeneous product with one factor of production, labour. The firms have access to the following technology.

$$X = eL, \qquad e(w - A) = 1 + \delta(w - A)^{\alpha}, \tag{1}$$

Where $\delta > 0$ and $0 < \alpha < 1$. Output is a function of efficiency units of labour. L is employment and e are units of worker effort in a home firm. A home firm can expand output either by increasing employment or by increasing the productivity of existing workers with a wage premium. A home firm will always choose the least cost way to

expand output. A is the outside option for workers in an industry. In partial equilibrium, it is a proxy for all competitive explanations of wage determination. δ is a parameter that acts as a proxy for exogenous conditions facilitating efficiency wage payments in a home firm. This among other things depends on the level of unemployment, union activity, training costs and job satisfaction. As a result of assuming $0 < \alpha < 1$, the effort function exhibits a diminishing marginal effort by workers in response to wages above the opportunity cost of labour ($e'(\cdot) > 0$ $e''(\cdot) < 0$). The inverse demand curve is assumed to be the following:

(2) $$P(Q) = 1 - Q,$$

First, we look at the optimality of an export subsidy per unit of *output.* Let $c = ((w/e) - s)$ be the home firm's unit variable cost net of a subsidy per unit of output. Let fixed costs of production be zero. We write the payoff to the a home firm as:

(3) $$\pi = (P(Q) - c)X$$

The presence of efficiency wage payments ensures that domestic workers earn economic rent. The government should not treat the rent component of a wage bill as a social cost of production. It should be included in social surplus as rent generated within the industry. The government is assumed to give equal weighting to all components of the following welfare function in evaluating welfare.

(4) $$G = N(\pi + (w-A)L - sX)$$

We will look at the behaviour of the home firms and the government in a two-stage game. We model the home firms as operating in an oligopolistic home export industry. The government moves first and is assumed to understand the dependence of the second stage on the first when choosing its optimal subsidy level. This will lead to a Nash equilibrium in each subgame. Hence, in all games, we consider the second stage first.

Under oligopoly, Cournot competition allows us to model the home government to anticipate various price cost margins for the home firms. Within a generalised efficiency wage model we can model the home firms to have various propensities to pay wage premia. In the following game, we will model stage two assuming the home firms play the Cournot strategy. In the *second stage* the home firms set their employment and wage levels simultaneously under a common strategy. Wage and employment setting a is modelled by the home firm choosing L and w (output) to maximise π, given s, while holding the output of all other home firms constant. The first order conditions for this optimisation are rewritten as the following:

(5) $$\pi_L = P(1+1/\eta) - w/e + s = 0$$

(6) $$\pi_W = P(1+1/\eta) - 1/e' + s = 0$$

η = price elasticity of industry demand. The employment and the wage level are set to ensure that the home firm produces output in the least cost way. The following holds and implies uniqueness and stability of the wage and employment setting equilibrium.

(7) $$D = \pi_{ww}\pi_{LL} - \pi_{wL}\pi_{Lw} > 0$$

The solution functions for the wage and employment levels can be solved from (5) and (6) and we find the comparative static effects of a change in s.

(8) $$w^{O}(A, \delta, \alpha), \qquad w_s = 0$$

$$L^{O}(A, \delta, \alpha, s, N), \qquad L_s > 0$$

The wage set by a home firm turns out to be independent of any product market variables. As in Solow (1979b), if the wage enters the short run production function, a cost-minimizing firm will not change its wage offer even though factors influencing output may be changing in the product market. Using (5) and (6), the wage in home firms is set where the percentage change in effort due to a percentage change in the wage is unity. This is the well-known Solow Condition.

(9) $$W/e = 1/e' \Rightarrow \varepsilon = (de/dw).(w/e) = 1$$

The optimal wage and hence effort level is set where $\varepsilon = 1$. This is Solow's *separation principle* that holds even under conditions of imperfect competition in the product market. The subsidy per unit of output does not change the least cost way to produce output. The efficiency wage remains unchanged.

In the *first stage*, the domestic government chooses s to maximise (4) in anticipation of the nature of competition in stage two. We write down the first order condition for the government as follows:

(10) $$G_s = N(\pi_s + (w\text{-}A)L_s - seL_s - X) = 0$$

We note that $\pi_s = -N(N-1)eXL_s + X$ and solve for the optimal export subsidy.

(11) $$s^o = -(N-1)X + (w - A)/e = (SMR - PMR) + (SMC - PMC)$$

The optimal subsidy is set to internalise an expected trade and domestic divergence that would result in the free trade equilibrium. If we substitute s^o in (11) into (5) and (6) the home firm is given an incentive to set an employment and wage level that maximises the *sum* of *joint* home firm and labour rents. The home firm is forced to take into account that as it expands output the industry price will fall, leading to a negative effect on the revenue of all other home firms. The home firm is also forced to include labour rent in its payoff function. From a social perspective, the government expects a home firm to *underestimate* the loss of revenue from inframarginal sales by -X(N-1) and to *overestimate* the marginal cost of employment by (w-A)/e. A tax is the optimal policy to internalise the trade divergence and a subsidy is the optimal policy to internalise the domestic divergence. The sign of the optimal subsidy depends on the relative sizes of the trade divergence (which depends on the intensity of intra home industry competition) and the domestic divergence (which depends on the conditions that facilitate efficiency wage payments). The motive for intervention is to capture the maximum industry rent (firm and labour) in consumerland since it is expected that home firms would fail to do so in the presence of efficiency wages and intra-industry competition.

Proposition 1: *The optimal export subsidy to a firm paying efficiency wages in a home industry can be positive or negative. The optimal subsidy depends negatively on the intensity of intra home industry competition and positively on the conditions that facilitate efficiency wage payments.*

The optimal subsidy is positive when the government expects that intra-industry competition is weak and wage premiums are high. Under these conditions, the government has an incentive to increase social surplus by pulling workers into this high wage premium industry by way of a subsidy per unit of output. Regardless of whether the subsidy is positive or negative, intervention ensures that each home firm produces the output of a home firm that maximises *joint* home firm profit and labour rent.

Next we turn to the optimality of a per unit of *labour* subsidy in the above framework. Let $c = ((w/e) - (s^*/e))$ be the home firm's unit wage cost net of a subsidy per unit of labour. Let fixed costs of production be zero. We write the payoff to a home firm as in (3). The government is assumed to give equal weighting to all components of the following welfare function in evaluating welfare.

$$G = N(\pi + (w-A)L - s^*L) \tag{12}$$

We will look at the behaviour of the home firms and the government in a two-stage game. The government moves first and is assumed to understand the dependence of the second stage on the first when choosing its optimal labour subsidy.

In the *second stage* the home firms set their employment and wage levels simultaneously under a common strategy. Wage and employment setting is modelled by

the home firm choosing L and w (output) to maximise π, given s^*, while holding the output of all other home firms constant. The first order conditions for this optimisation are rewritten as the following:

(13) $$\pi_L = P(1+1/\eta) - w/e + s^*/e = 0$$

(14) $$\pi_W = P(1+1/\eta) - 1/e' \quad = 0$$

η = price elasticity of industry demand. The employment and the wage level are set to ensure that the home firm produces output in the least cost way. (7) holds and ensures the uniqueness and stability of the wage and employment setting equilibrium. The solution functions for the wage and employment levels can be derived from (13) and (14). We find the comparative static effects of changes in s.

(15) $$w^O (A, \delta, \alpha, s^*), \qquad w_s < 0$$

$$L^O (A, \delta, \alpha, s^*, N), \qquad L_s > 0$$

The wage set by a home firm is not independent of the labour subsidy. Output in a home firm can either be expanded by hiring more labour or it can be expanded by inducing existing workers to be more productive by paying them a higher wage premium. A home firm will always choose the least cost way to produce output. A labour subsidy will make production relatively more employment intensive and less effort intensive. Hence we see a rise in employment and a *fall* in the wage premium. Using (13) and (14), given

the labour subsidy, the optimal wage set in home firm is where the percentage change in effort due to a percentage change in the wage is elastic. The higher the subsidy the further we move away from the Solow Condition.

(16) $$\varepsilon - (e/e')s^* = 1 \quad : \varepsilon = (de/dw).(w/e) \quad > 1$$

The optimal wage and hence effort level is set where $\varepsilon > 1$. Solow's *separation principle* from product market variables still holds. The labour subsidy changes the optimal employment and effort intensities in home firm production. We see an expansion in employment and a fall in the wage premium as the subsidy increases. Katz and Summers (1989) *imposed* the opposite result in their model. They felt the ability of workers to extract rent should increase as labour demand increases due to the labour subsidy. It is the firm that *voluntarily* gives the wage premium and will decrease it in response to a labour subsidy. The subsidy makes production more labour intensive but less effort intensive. Expansion of employment becomes a relatively cheaper way to expand output compared to giving wage premium incentives that increase the productivity of existing workers.

In the *first stage*, the domestic government chooses the labour subsidy to maximise (12) in anticipation of the nature of competition in stage two. We write down the first order condition for the government as follows:

(17) $$G_{s*} = N(\pi_{s*} + (w\text{-}A)L_{s*} + Lw_{s*} - s^*L_{s*} - L) = 0$$

We note that $\pi_{s*} = -e(N-1)XL_{s*} - (N-1)e'LXw_{s*} + L$. Taking a total differential

(1) and setting it equal to zero, we note that dw/dL = -(e/e'L). We solve for the optimal labour subsidy as $s^{*o} = 0$.

The optimal labour subsidy has no effect on the output produced by home firms. The same output is produced with more labour and less effort. Product market rent remains unchanged. Labour rent also remains unchanged. Even though home firms are more labour intensive, the wage premium falls and ensures that overall the rent component of the wage bill is unchanged. This suggests that a labour subsidy that pulls employment into "sunrise" exporting firms does not increase welfare. The labour rent creation motive does not exist here as the wage premium being offered by the home firms to their workers declines as the labour subsidy expands employment leaving labour rent unchanged.

Proposition 2: The optimal labour subsidy to an exporting firm paying efficiency wages is zero.

The labour rent creation motive for a subsidy to exporting firms only exists when intra home industry competition is weak and the wage premium offered by home firms is high. Given that the government anticipates these conditions, the subsidy must be targeted at output and not at employment for a net welfare gain.

Section II: The New School and Trade Policy

The set of players in this section consists of a home firm, a foreign firm and a home government. We abstract from having intra-industry competition between firms from the same country. We model the home government to expect both imperfect *international* intra-industry competition and efficiency wage payments in the industry. In response to this, the home government designs an optimal export subsidy to ensure that the home firm produces the socially optimal output. As in section one, it can be shown that a per unit of labour subsidy is not optimal in the presence of efficiency wage payments. It changes the labour intensity of production without increasing output, leaving both the product market and labour rent unchanged.

One key element of this analysis is that the home government can only impose a policy on the home firm in formulating export policy. The government has full information on the nature of the competition between the firms in the industry. The government is modelled to anticipate the optimal response of the foreign firm to any action that it undertakes. We examine export policy where the firms can either play the Cournot or Bertrand Strategy.

First, we examine export policy when the firms in the industry play the Cournot strategy. The home and foreign firm produce a homogeneous product. A home firm produces X with the same technology as in (1) and earns a payoff π. A foreign firm produces Y and earns a payoff π^*. The inverse demand curve is assumed to be following:

$$P = 1 - Q, \qquad Q = X + Y \tag{18}$$

The payoff to the home firm is written as in (3). Let c^* be the foreign firm's unit variable cost. The foreign fixed cost of production is assumed to be zero. The payoff to the foreign firm is the following:

(19) $$\pi^* = (P(Q) - c^*)Y$$

The government is assumed to give equal weighting to all components on the welfare function in (4) setting N = 1. We will look at the behaviour of the firms and the home government in a two-stage game. The government moves first and is assumed to understand the dependence of the second stage on the first. In the *second stage* the firms set their output levels simultaneously using the Cournot strategy. We model wage and employment setting (output setting). Given s, and holding Y constant, the home firm chooses L and w to maximise π. The first order conditions are written down in the same way as in (5) and (6). (7) holds and ensures we have uniqueness and stability in our wage and employment setting equilibrium.

At the same time as the wage and employment setting process in the home firm, the foreign firm chooses Y to maximise π^*, holding X constant. The foreign firm's first and second order conditions are as follows:

(20) $$\pi^*_Y = P + YP' - c^* = 0, \qquad \pi^*_{YY} < 0$$

The principal minors of the following determinant alternate in sign, starting negative, and ensure the uniqueness and stability of the Nash equilibrium:

(21) $$D = \begin{vmatrix} \pi_{LL} & \pi_{Lw} & \pi_{LY} \\ \pi_{wL} & \pi_{ww} & \pi_{wY} \\ \pi^*_{YL} & \pi^*_{Yw} & \pi^*_{YY} \end{vmatrix} < 0$$

The solution functions for the wage and employment levels can be solved from (5),(6) and (21) and we find the comparative static effects of changes in s.

(22)
$$w^o (A, \delta, \alpha), \qquad w_s = 0$$
$$L^o (A, \delta, \alpha, s, c^*), \qquad L_s > 0$$
$$Y^o (A, \delta, \alpha, s, c^*), \qquad Y_s < 0$$

The optimal wage and hence effort level is set where $\varepsilon = 1$. This is Solow's *separation principle.* The per unit of output subsidy does not change the optimal intensity of employment relative to worker productivity in producing output. The least cost way to produce output and the efficiency wage remain unchanged.

In the *first stage*, the domestic government chooses s to maximise (4) in anticipation of the nature of competition in stage two. Setting N =1, we write down the first order condition for the government as in (10). Making use of the envelope theorem, we note that $\pi_s = XP'Y_s + X$ and solve for the optimal subsidy from (10).

(23) $$s^o = -(P - c)(Y_s/eL_s) + (w - A)/e = (SMR - PMR) + (SMC - PMC) > 0$$

The optimal subsidy in (23) induces the home firm to produce the same level of output that it would produce if it had the benefit of first mover advantage (thus anticipating the optimal response function of the foreign firm) *and* included labour rent

in its payoff function. With first mover advantage the home government anticipates a trade divergence. The home government anticipates that the foreign firm would decrease its output and partially offset the fall in the industry price as the home firm expands its output (productivity is constant in response to the subsidy and output increases due to an expansion in employment). This offsets the revenue lost on inframarginal sales. From a social perspective, the government expects the home firm to *overestimate* the loss on inframarginal sales when it produces output in the simultaneous move equilibrium[5]. This is what drives the wedge between the SMR and the PMR in home production. In Corden's terminology, this leads to the government's anticipation of a trade divergence.

The domestic divergence is created by the presence of efficiency wage payments. The home government anticipates that the home firm will treat the rent component of its wage bill as a cost. From a social perspective, the government expects the home firm to *overestimate* the marginal cost of producing in the simultaneous move equilibrium. This is what drives the wedge between the SMC and the PMC of home production. In Meade's terminology, this leads to the government's anticipation of a domestic divergence. The motive for the subsidy is rent (firm and labour) creation. The government does this by exploiting the price support offered by the foreign firm. In addition it also pulls workers into a home firm that pays a wage premium. What determines the magnitude of the subsidy in the above model? The more profitable is the home firm, in the simultaneous move equilibrium, the greater the government can exploit the *partial price support* that is offered by the foreign firm, to increase the home firm rent. The wage mark-up depends on the presence of conditions that facilitate efficiency

[5] In the phraseology of Bulow et al (1985) output levels in this game are strategic substitutes.

wage payments. It is independent of conditions in the product market. The subsidy promotes an expansion of employment in a wage premium industry. The bigger the wage premium, the greater social benefit (in terms of labour rent) of pulling employment into a high wage firm. The government anticipates a bigger welfare gain in product market rent, the more profitable is the home firm. It anticipates a bigger welfare gain in labour rent, the higher the is wage premium paid out by the home firm.

Proposition 3: A home government has a unilateral incentive to offer an export subsidy to a home firm paying efficiency wages under international Cournot competition. The optimal subsidy is increasing in the profitability of the home firm and increasing in the wage premium paid by the home firm.

The optimal subsidy is positive since the government expects international intra-industry competition to be weak and the home firm to pay a wage premium. Under these conditions the government has an incentive to increase labour rent by pulling workers into an exporting firm that pays a wage premium. These are the same conditions that make an export subsidy optimal in the old school.

We now turn to the analysis of international Bertrand competition to show that the general results that emerge from the above analysis are robust to changing the strategy of the firms to the Bertrand strategy. The home firm produces X, with the same technology as in (1), at a price P and earns a payoff π. The foreign firm produces Y at a price P^* and earns a payoff π^*. The demand conditions are derived by an application of Salop's (1979a) model. Consumers are located uniformly on a circle with a perimeter equal to one and the density of consumers is unitary around the circle. The firms are

located symmetrically around the circle. The distance between the home and foreign firm's location is equal to 1/2. Each consumer buys one unit of the good and has a transport cost τ per unit of the distance travelled to each location. Sales for a home firm are equal to 2d. d is the per unit distance from the consumer who is indifferent between travelling to the location of a home firm or a foreign firm on the circle. The equation of the *indifferent consumer* for a home firm's product is $P + \tau d = P^* + \tau(1/2 - d)$. We solve for a home firm's demand function as the following:

(24) $$2d = X = X(P, P^*) = 1/2 + (P^* - P)/\tau$$

The equation of the indifferent consumer for a foreign firm's product is $P^* + \tau d = P + \tau(1/2 - d)$. We can solve for a foreign firm's demand function as the following:

(25) $$2d = Y = Y(P, P^*) = 1/2 + (P - P^*)/\tau$$

Let $c = ((w/e) - s)$ be the variable cost of production net of a subsidy per unit of output. We write the payoff to a home firm as:

(26) $$\pi = (P - c)Y(P, P^*)$$

Let c^* be the variable cost of foreign production and the payoff to a foreign firm be,

(27) $$\pi^* = (P^* - c^*)X(P, P^*)$$

The payoff to the domestic government is the same payoff as in (4), setting N = 1. In the *second stage,* the home firm sets its price and wage level and at the same time the foreign firm sets its price level. To model wage and price setting, the home firm, given s and holding P^* constant, chooses P and w to maximise π. The first order conditions for this optimisation are rewritten as the following:

(28) $$\pi_P = P(1+1/\eta) - w/e + s = 0$$

(29) $$\pi_W = P(1+1/\eta) - 1/e' + s = 0$$

η = price elasticity of industry demand. The following holds and implies uniqueness and stability in the wage and price setting equilibrium .

(30) $$D = \pi_{ww}\pi_{PP} - \pi_{wP}\pi_{Pw} > 0$$

At the same time as the wage and price setting process in the hone firm, the foreign firm chooses P^* to maximise π^*, holding P constant. The foreign firm's first and second order conditions are as follows:

(31) $$\pi^*_{P*} = (P^* - c^*)Y_{P*} + Y = 0, \qquad \pi^*_{P*P*} < 0$$

The principal minors of the following determinant alternate in sign, starting negative, ensuring uniqueness and stability of the Nash equilibrium:

(32) $$D = \begin{vmatrix} \pi_{PP} & \pi_{Pw} & \pi_{PY} \\ \pi_{wP} & \pi_{ww} & \pi_{wY} \\ \pi^*_{YP} & \pi^*_{Yw} & \pi^*_{YY} \end{vmatrix} < 0$$

The solution functions for the wage and price levels can be solved from (28),(29) and (31) and we find the comparative static effects of a change in s.

(33) $$w^O(A, \delta, \alpha), \qquad w_s = 0$$

$$P^O(A, \delta, \alpha, s, c^*, \tau), \qquad P_s < 0$$

$$P^{*O}(A, \delta, \alpha, s, c^*, \tau), \qquad P^*_s < 0$$

The optimal wage and hence effort level are set where $\varepsilon = 1$. This is Solow's *separation principle*. The least cost way to produce output (hence the efficiency wage) remains unchanged in response to the export subsidy.

In the *first stage*, the domestic government chooses s to maximise (4) in anticipation of the nature of competition in stage two. Setting N=1 and making use of the envelope theorem, we note that $\pi_s = (P - c)x_{p*}P^*_s + X$. We solve for the optimal subsidy as the following:

(34) $$s^O = -(P - (w/e))(X_{P*}P^*_s/X_PP_s) + (w - A)/e = (SMR - PMR) + (SMC - PMC)$$

The optimal subsidy in (34) induces the home firm to produce the same level of output that it would produce if it had the benefit of first mover advantage (thus anticipating the optimal response function of the foreign firm) and if it had included labour rent in its payoff function. The trade divergence is created by giving the home

government first mover advantage. With a first mover advantage, the home government anticipates that the foreign firm will price follow in response to any price the home firm sets. This would increase the revenue lost on inframarginal sales. From a social perspective, the government expects the home firm to *underestimate* the loss on inframarginal sales when it produces output in the simultaneous move equilibrium[6]. This is what drives the wedge between the SMR and the PMR in home production.

The domestic divergence is created by the presence of efficiency wage payments in the home firm. The home government anticipates that the home firm will treat the rent component of the wage bill as a cost. From a social perspective, the government expects the home firm to *overestimate* the marginal cost of producing in the simultaneous move equilibrium. This is what drives the wedge between the SMC and the PMC of home production. The motive for the subsidy is rent (firm and labour) creation. With a tax, the government can increase home firm rent by exploiting the price following offered by the foreign firm. With a subsidy, the government can increase labour rent by expanding employment in a firm that pays a wage premium to its workers. The sign of the optimal subsidy depends on the degree of product differentiation and the size of the wage premium in our model.

Proposition 4: The optimal export subsidy to a home firm paying efficiency wages under international Bertrand competition can be positive or negative. The optimal subsidy is increasing in the degree of product differentiation (profitability) and increasing in the wage premium paid by the home firm.

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[6] In the phraseology of Bulow et al (1985) output levels in this game are strategic complements.

The optimal subsidy becomes positive when the government expects that international intra-industry competition is weak (a high degree of product differentiation) and the wage premium paid out to be high. Under these conditions the government has an incentive to increase social surplus by pulling workers into the exporting firm that pays a wage premium. These are the same conditions that gave the home government a labour rent creation motive for an export subsidy in both the old school and in the new school under international Cournot competition.

Conclusion

In this chapter we examined export policy in the presence of imperfect intra-industry competition and efficiency wage payments. We looked at *export* policy in the presence and in the absence of international competition. A per unit of *output* subsidy can be optimal when the home government expects that intra-industry competition is weak and home workers, for efficiency reasons, receive a high wage premium. These conditions give the home government an incentive to increase social surplus by pulling labour into home exporting firms that pay a high wage premium. There is a labour rent creation motive for export policy. A per unit of *labour* subsidy to a home exporting firm paying efficiency wages is shown not to increase social welfare. Even though the home exporting firms become more labour intensive, the wage premium offered to workers falls and ensures that the overall rent component of a wage bill is unchanged. There is no rent (labour or firm) creation motive for a home government to use a labour subsidy in the presence of efficiency wage payments.

CHAPTER 4

IMPERFECT COMPETITION IN PRODUCT AND LABOUR MARKETS: THE THEORY AND EVIDENCE OF VERTICAL SPILLOVERS[1]

[1] *Joep Konings did most of the empirical work in section III.*

Introduction

Efficiency wage theories in recent years have been put forward as attractive ways of explaining involuntary unemployment and other aspects of the labour market. However the best general evidence for efficiency wage payments thus far is based on a *proof by contradiction* approach. Studies in the U.S. have documented large and persistent inter-industry and firm wage differentials (Krueger and Summers (1988), Blackburn and Neumark (1988), Katz and Summers (1989), Groshen (1991) and Gibbons and Katz (1992)). These studies reject the hypothesis that competitive and bargaining theories can explain one hundred percent of the wage differentials that exist in U.S. industry. Indirectly they see this as evidence for the existence of efficiency wage payments. Solow's (1979) model captures the essence of the efficiency wage argument[2]. The key feature of his model and all efficiency wage models is that the wage has a dual function. One function is to hire labour and the other is to create incentives that reduce efficiency costs. Our key insight is to note that rent sharing under efficiency wage payments is fundamentally a different type of rent sharing than that under wage bargaining. The wage premium that results from an efficiency wage payment is only a fraction of the product market rent it creates. This is a share in *additional rent* created by the wage premium itself rather than a share in the *absolute rent* created by the firm. A firm does not commit to paying wage premium incentives if there is no net gain in product market performance from doing so.

To find evidence of efficiency wage payments in firms we take a very different

[2] There are five important efficiency wage models that explain why firms find it *profitable* to pay wages above the opportunity cost of labour: The Shirking Model (Shapiro and Stiglitz (1984)), The Labour Turnover Model (Salop (1979)b), The Adverse Selection Model (Weiss (1980)), The Sociological Models (Akerlof (1984)) and The Union Threat Model (Dickens (1986)).

road to that taken by the advocates of the proof by contradiction approach. Our approach is in the same spirit of the more direct tests of efficiency wage theories. Most efficiency wage theories predict a positive relationship between a wage premium incentive and performance. Up to now performance was measured in a very specific way which related to a particular model of efficiency wage theory[3]. Most of this empirical work finds a positive and significant relationship between a specific measure of performance and a wage premium. However, the wage premium never seems *to pay for itself.* Efficiency wage theory would predict that it should only be a fraction of the rent it creates. We believe the decision to be a high wage firm infers many benefits and not just one. The key feature is that the wage premium incentives will lead to better product market performance. Exactly how the wage premium incentives reduce efficiency cost is treated as a *black box.* The net outcome will always be an improvement in product market performance. Our measure of a firm's product market performance is market share. A firm that infers the benefits of being a high wage premium employer will, as a result, do *relatively* better in product market performance as measured by market share.

The theory we develop tracks vertical spillovers from wage determination in an *upstream* labour market to market share determination in a *downstream* product market and vice versa. Specifically, we track vertical spillovers within Sutton's (1991) oligopoly framework under alternative theories of wage determination. Variations in the outside option for workers in an industry are taken not to give one firm an advantage over another and generates no vertical spillovers between wage determination and market

[3] Performance has been measured in terms of self-reported effort, worker and pay satisfaction, training costs, absences, turnover, job queues, productivity, disciplinary dismissals and supervisory intensity(Levine (1986 & 1992), Bielby and Bielby (1988), Akerlof et al (1988), Holzer et al (1988), Allen (1984), Holzer (1990), Wadhwani and Wall (1991), Cappelli and Chauvin (1991) and Leonard (1987)).

share determination in the downstream product market[4]. The theory predicts that efficiency wage payments creates a unique downstream vertical spillover that leads to a positive relationship between unit wage cost and performance in the product market. The presence of wage bargaining is shown to drive a two-way vertical spillover. The downstream spillover due to the presence of wage bargaining leads to a negative relationship between unit wage cost and performance in the product market. Wage bargaining can also lead to a positive relationship between unit wage cost and market share performance. However, it is a spillover that flows in the *opposite direction* to that created by efficiency wages.

We set out to discriminate between the *downstream* spillover due to the presence of wage bargaining and that due to efficiency wage payments. To this end, we use our theory to *constrain the data.* Our basic data source is a panel of 993 UK *large* manufacturing firms[5]. Our theory relates to industries where goods do not have vertical attributes. For this reason, we focus exclusively on relatively homogenous goods industries. We split the data into a high and low unionised sample of firms. This is an attempt to constrain the data to discriminate between the downstream vertical spillovers due to efficiency wage payments and wage bargaining.

The average wage of the low unionised firms over the period 1973-1982 was very much in line with the high unionised sample. However the wage dispersion is

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[4] A competitive theory of the labour market allows an asymmetric compensating differential (due to idiosyncratic features of firms) to create a downstream vertical spillover that leads to a negative relationship between unit wage cost and market share performance (see Konings and Walsh (1993)).

[5] Brown and Medoff (1989) show that large U.S. firms, in employment size, pay on average 15% more than smaller firms. The U.K. firms we examine have an average employment of 4,550 in 1979.

greater within the low unionised sample and grows over the period analysed. Over the period 1973-1982, exploiting the pooled cross sectional and time series dimension of our data set, we find evidence, in the low unionised sample, that firms voluntarily paid high wages to induce better market share performance. We take this as direct evidence that the high wage firms in this sample paid efficiency wages. We also find evidence, in the high unionised sample, that firms involuntarily paid high wages, which had a detrimental effect on their market share performance.

Section I develops the generalised efficiency wage oligopoly model and we examine the downstream vertical spillover due to the presence of efficiency wage payments. Section II develops the generalised wage bargaining oligopoly model and examine the two-way vertical spillovers due to the presence of wage bargaining. Section III uses the theory on vertical spillovers to constrain the data and we conclude with the empirical evidence.

I. The Efficiency Wage Oligopoly Model

The model of the product market originates from Sutton (1991). Under oligopoly, a firm's equilibrium price cost margin can be modelled to vary from the monopoly to the competitive level, for a given historically determined level of concentration. As in Sutton (1991), by changing the *toughness of price competition* (by changing the type of strategic competition and the degree of product differentiation) it is possible to generate any price cost margin which lies in between these extremes. We model price competition to be either very weak or extremely strong. We work with homogeneous Cournot competition as a *building block* to model weak price competition. Homogeneous Bertrand competition is used as a *building block* to model the limit of strong price competition. If a relationship between two variables holds at the two extremes, it can be shown that it also holds for any intensity of price competition that one could model in between these two extremes by imposing different degrees of product differentiation into the models we work with[6]. Product differentiation relaxes competition in the product market. However, switching from Bertrand to Cournot competition has the same effect. Furthermore, the changes that result due to switching occur gradually and continuously for the different intensities of competition one could model inbetween these two extremes.

We model the labour market by embedding Solow's (1979) efficiency wage model into the oligopoly framework. This model captures the essence of the efficiency wage argument and is treated as a general efficiency wage model. Two firms produce a homogeneous product with one factor of production, labour. Firm 1 produces X and

[6] The relationship will hold and a unique equilibrium price cost margin is obtained, if and only if product differentiation is imposed exogenously on the demand conditions.

earns a payoff π, while firm 2 produces Y and earns a payoff π^*. The inverse demand curve is written as the following:

(1) $$P = P(X + Y), \qquad P'(\cdot) < 0 \quad P''(\cdot) = 0$$

P is the industry price. We write the technology available to firm 1 as the following:

(2) $$X = F(eL), \quad e(w - A) = 1 + \delta(w - A)^{\alpha}, \quad \delta \geq 0, \quad 0 < \alpha < 1$$

Output in firm 1 is produced by either hiring more labour or by increasing the productivity of existing workers with a wage premium. Where L is employment, e are units of worker effort and w is the per unit wage cost of workers. We assume that the production function exhibits diminishing marginal productivity in efficiency units of labour ($F'(\cdot) > 0$, $F''(\cdot) < 0$). A is the outside option for workers in the industry. δ is a parameter that proxies for the conditions that facilitate efficiency wage payments in firm 1. This among other factors depends on the level of unemployment, union activity, training costs, monitoring costs and job satisfaction. As a result of assuming $0 < \alpha < 1$, the effort function is diminishing in wages above the outside option ($e'(\cdot) > 0$, $e''(\cdot) < 0$). The technology available to firm 2 we write down as the following:

(3) $$Y = F^*(e^*L^*), \qquad e^*(w^* - A) = 1 + \delta^*(w^* - A)^{\alpha^*}, \quad \delta^* = 0$$

Compared to the workers in firm 1, worker productivity in firm 2 is not as responsive to a wage premium incentive. We model this in the extreme by setting $\delta^* = 0$. L^* is

employment and w^* is the per unit cost of workers in firm 2. We also assume that the production function exhibits diminishing marginal productivity of labour ($F^{*\prime}(\cdot) > 0$, $F^{*\prime\prime}(\cdot) < 0$). The payoff functions for firms 1 and 2 are respectively:

(4) $$\pi = P(X + Y)X - wL$$

(5) $$\pi^* = P(X + Y)Y - w^*L^*$$

We first embed the efficiency wage payments into a model of weak price competition. Both firms move simultaneously and unilaterally. Firm 1 chooses L and w (output) to maximise π, holding L^* (Y) constant. Firm 2, given w^*, chooses L^* to maximise π^*, holding L constant. We first write down and examine the first order conditions for employment and wage setting in firm 1, where η is the price elasticity of industry demand.

(6) $$\pi_L = P(1 + 1/\eta)F' - w/e = 0$$

(7) $$\pi_w = P(1 + 1/\eta)F' - 1/e' = 0$$

Output is produced in the least cost way using the optimal intensity of labour and worker productivity. The wage that is set satisfies the Solow Condition, where the elasticity of effort with respect to the wage is unity. We show this in figure 1 where w_o and e_o satisfy the condition $\varepsilon = 1$. Using (6) and (7) we can express the optimal efficiency wage and its partial derivative with respect to δ as the following:

(8) $(w/e)^{o}(A , \delta, \alpha), \qquad (w/e)^{o}_{\delta} < 0$

The optimal efficiency wage is decreasing in δ holding A and α constant. In figure 4:1 a rise in δ from δ_0 to δ_1 leads to an increase in the wage set from w_0 to w_1 and to a greater extent a rise in effort from e_0 to e_1. The optimal efficiency wage set is independent of product market factors. This leads us to state the following proposition.

Proposition 1: *There are no upstream vertical spillovers from the product market to wage determination in the labour market due to the presence of efficiency wage payments.*

Rent sharing in the efficiency wage model is independent of the absolute product market rent created. The workers get a fraction (the wage premium) in the additional rent that they themselves create by lowering efficiency costs. We re-express the optimal condition for employment setting in firm 1, assuming firm 1 satisfies the Solow Condition in wage setting.

(9) $$\pi_L = P(1 + 1/\eta)F' - (w/e)^{o} = 0$$

Employment is set at a level where the marginal revenue product of labour, which is conditional on L^*, is equal to the optimal unit efficiency wage cost. This is expressed as the optimal response function $L = R(L^*)$. The first order condition for optimal employment setting in firm 2 is the following:

(10) $$\pi^*_{L^*} = P(1 + 1/\eta^*)F^{*\prime} - w^* = 0$$

Employment is set at a level where the marginal revenue product of labour, which is conditional on L, is equal to the per unit wage cost. This condition is expressed as the optimal response function $L^* = R^*(L)$. The following implies uniqueness and stability of the Nash equilibrium in employment setting.

(11) $$D \equiv \pi_{LL}\pi^*_{L^*L^*} - \pi_{LL^*}\pi^*_{L^*L} > 0$$

The solution functions and the comparative static effect of a change in $(w/e)^\circ$ on the employment levels can be found from the first order conditions (9) and (10). We express them as the following:

(12) $$L^0(\, w^*, (w/e)^\circ\,), \qquad dL/d(w/e)^\circ = \pi^*_{L^*L^*}/D < 0$$

$$L^{*0}(\, w^*, (w/e)^\circ\,), \qquad dL^*/d(w/e)^\circ = -\pi^*_{L^*L}/D > 0$$

A fall in the optimal efficiency wage (a rise in δ) will increase the employment level in firm 1. To a lesser extent it will lead to a fall in employment in firm 2. Using (2), (3) and (12) we solve for market share (Φ) and take a partial derivative of the function with respect to δ.

(13) $$\Phi = \Phi(\, w^*, A\,, \delta, \alpha\,), \qquad \Phi_\delta > 0$$

Market share is positively related to the downstream vertical spillover due to efficiency wage payments. In figures 4:2 and 4:3 we give a diagrammatic illustration of this spillover. We start from a symmetric equilibrium where $X_0 = Y_0$. Figure 4:2 illustrates the technologies for the two firms and the equilibrium output levels as a function of efficiency units of labour. Figure 4:3 shows us the conditions for optimal employment setting. Employment in both firms is set where the conditional marginal revenue product of labour is equal to a firm's efficiency wage level. The efficiency wage in firm 2 is set exogenously by assuming that $e^*=1$. The efficiency wage in firm 1 is set where the Solow Condition is satisfied $\varepsilon=1$. In the symmetric equilibrium $(w/e)^o = w^*$ and employment is also set at the same level $L_o=L^*_o$.

We wish to show the effect a change in δ has on the market share and the on wage set by firm 1, holding A and w^* constant. A rise in δ from δ_0 to δ_1 leads to a rise in W from W_0 to W_1. To a greater extent it leads to a rise in e from e_o to e_1 as shown in figure 1:1 where again $\varepsilon=1$. This leads to a fall in the optimal efficiency wage level to $(W/e)_1$. This causes a rise in employment (output) in firm 1. To a lesser extent it causes a fall in employment (output) in firm 2 This is summarised in figure 4:2 and 4:3. In firm 1 the workers get some share of the extra rent they create from being more productive. The firm uses the wage for a dual function. One function is to hire labour. The other is to improve worker productivity. The efficiency wage is lower and the firm becomes more cost competitive in efficiency terms relative to its rival. Thus firm 1 gains market share even though it seems to have a higher unit wage cost. One might expect market share to decline at a diminishing rate as δ rises since we have assumed diminishing marginal productivity in both firms' production functions. One should note from figure 4:3 that the conditional demand for labour under Cournot competition shifts

up in response to δ as employment in firm 2 falls. To a greater extent the conditional demand for labour for firm 2 shifts down under Cournot competition in response to a rise in δ. This process causes to market share to rise at an increasing rate for firm 1.

We next examine the downstream vertical spillover due to efficiency wage payments in the limit of strong price competition. Working in the above framework we change the strategic variable of the firms. They unilaterally and simultaneously set their respective price levels. Given $(w/e)^{\circ}$ and holding P^{*} constant, firm 1 sets its P to maximise π. Given w^{*} and holding P constant, firm 2 sets P^{*} to maximise π^{*}. In the case of symmetric efficiency wage costs, the price that induces a Nash equilibrium is $P^{e} = (w/e)^{\circ} = w^{*}$. Starting from this symmetric equilibrium, a rise in δ, by the smallest amount, ensures that firm 1 enjoys the entire market, while firm 2 will choose not to enter. If both firms were to enter the market the optimal response of firm 1 is to set a price $(w/e)^{\circ} \leq P < w^{*}$, even though $w > w^{*}$. This knowledge prevents firm 2 entering the market. As in the case of weak competition, market share increases with a rise in δ but at the fastest rate possible. It causes market share to rise to one.

We have examined the downstream vertical spillover due to efficiency wages under the assumption of either weak or extremely strong price competition. We could model the different intensities of price competition in between these two extremes by imposing different degrees of product differentiation into the above models. We formulate our results as outlined in the beginning of this section and proposition 2 summarises the general result that we take from the gerenalised efficiency wage oligopoly model.

Proposition 2: *The downstream vertical spillover due to efficiency wage payments leads to a positive relationship between a firm's market share performance and unit wage cost. This becomes stronger as we increase the intensity of price competition in the product market.*

II. The Wage Bargaining Oligopoly Model.

In this section we demonstrate the *two-way* vertical spillovers that operates in the presence of wage bargaining. There is empirical evidence to suggest that price cost mark-ups in product markets are very much influenced by the presence of unions. This is a result of the downstream spillover in the presence of wage bargaining[7]. There is also empirical evidence on the influence a price cost mark-up has on the wage mark-up created by union activity. This is a result of the upstream spillovers in the presence of wage bargaining[8]. We model the product market as in section I. The labour market is modelled within a generalised bargaining framework. We work with equations (1) to (5), setting $\delta = 0$ and introduce a union into firm 1. The union is risk neutral and maximises the following function in which the union only gets utility from a wage above the outside option for its workers.

$$U(w) = (w - A) \tag{14}$$

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[7] Freeman (1983), Voos and Mishel (1986) and Domowitz et al. (1988) for the U.S. and Karier (1985) and Dowrick (1990) for the U.K.

[8] Stewart (1990) found that unions in the U.K. establish bigger mark-ups in firms with greater market power and market share. There is also evidence from Belgian Manufacturing Sectors (Bughin (1991a&b)) that unions are able to extract a significant amount of rent from firms with the highest market shares.

We first examine the vertical spillovers under weak price competition. In Firm 1 bargaining is over the wage only and the firm maintains the right to set employment. Given (14), efficient contracts will lie on the labour demand curve[9] (see appendix B for the analysis of vertical spillovers under wage and employment bargaining). To model *wage setting* in firm 1 we use the (generalised) asymmetric Nash bargaining solution for (two player) non-cooperative bargaining environments which approximates the unique perfect equilibrium outcome of a strategic time preference model (see Binmore et al. (1986)). The Nash bargaining solution is obtained by maximising the Nash product of the payoff functions for the two parties net of opportunity costs (threat points). We express the generalised Nash product as the following:

$$\Omega = (U - U^{\bullet})^{\beta}(\pi - \pi^{\bullet})^{1-\beta} \tag{15}$$

$U^{\bullet}$ is the opportunity cost to the union and $\pi^{\bullet}$ is the opportunity cost to firm 1. The threat points in this model are $(U^{\bullet}, \pi^{\bullet}) = (0, 0)$[10]. ß is the relative bargaining power of the union, which goes up as ß approaches one. We rewrite (15) using the above and (14) as,

$$\Omega = (w - A)^{\beta} \pi^{1-\beta} \tag{16}$$

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[9] Evidence is found in both the US and UK for this assumption, Farber (1986), Oswald (1987), Clark and Oswald (1989) and Layard et al. (1991).

[10] A threat point cannot correspond to an outside option (see Sutton (1986)). The inclusion of the outside option only affects the equilibrium outcome of the strategic models if one of the parties prefers the outside option point to one of the agreement points. Otherwise the threat to leave the bargain is not credible.

To get the Nash bargaining solution we maximise (16) with respect to w, holding L and L^* constant. The first order condition is expressed as the following:

(17) $$\Omega_w = ß/(w - A) + ((1-ß)/\pi)\pi_w = 0, \qquad \Omega_{ww} < 0$$

The wage set, ensures the workers get a share in the absolute product market rent created by the firm. This share depends on the relative bargaining strength of the two players. This condition can be re-expressed as the optimal response function $w = R^*(L, L^*)$. *Employment setting* in firm 1 takes place simultaneously to the wage bargaining process. Setting $\delta = 0$, the first order condition is the same as equation (9). This can be written as the optimal response function $L = R(w, L^*)$.

The wage in firm 2 is set exogenously. We model *employment setting* in firm 2 simultaneously to the wage and employment setting in firm 1. The first order condition is the same as equation (10) and is expressed as the optimal response function $L^* = R(L)$. The principle minors of the following determinant must alternate in sign, starting negative, to ensure the stability and uniqueness of the Nash equilibrium.

(18) $$D = \begin{vmatrix} \Omega_{ww} & \Omega_{wL} & \Omega_{wL^*} \\ \pi_{Lw} & \pi_{LL} & \pi_{LL^*} \\ \pi^*_{L^*w} & \pi^*_{L^*L} & \pi^*_{L^*L^*} \end{vmatrix} < 0$$

The solution functions for the wage and employment variables can be solved from the above optimal response functions. Taking a total differential of (9), (10) and (17) we apply Cramer's rule to find the comparative static effects of changes in ß and w^*.

$$w^{O}(A, \beta, w^{*}), \qquad w_{\beta} = -\Omega_{w\beta}D_1/D > 0, \quad w_{w^{*}} = -D_2/D > 0$$

(19) $$L^{O}(A, \beta, w^{*}), \qquad L_{\beta} = -\Omega_{w\beta}\pi^{*}_{L^{*}L^{*}}/D < 0, \quad L_{w^{*}} = -D_3/D > 0$$

$$L^{*O}(A, \beta, w^{*}), \qquad L^{*}_{\beta} = \Omega_{w\beta}\pi^{*}_{L^{*}I}/D > 0, \quad L^{*}_{w^{*}} = D_4/D < 0$$

The downstream vertical spillover in the presence of wage bargaining, a rise in union bargaining power, causes a fall in employment and a rise in the unit wage cost in firm 1. To a lesser extent it causes a rise in employment in firm 2 [11]. A rise in w^{*} represents an upstream vertical spillover in the presence of wage bargaining. It is an exogenous change that improves the market share of firm 1. A rise in w^{*} increases employment and the wage level in firm 1. To a greater extent it decreases employment in firm 2. From (19), we can solve for the market share of firm 1 and get the partial derivatives of this with respect to ß and w^{*}.

(20) $$\Phi = \Phi(A, \beta, w^{*}), \qquad \Phi_{\beta} < 0, \quad \Phi_{w^{*}} > 0$$

Market share is negative in ß and positive in w^{*}. The downstream vertical spillover in the presence of wage bargaining lowers market share performance and increases unit wage costs. The union ends up with a bigger share of a smaller rent. An exogenous change in the product market that improves the market share performance of firm 1 will create an upstream vertical spillover in the presence of wage bargaining that increases unit wage cost. In this case the union gets the same share of a bigger rent. In figure 4:4 amd 4:5 we give a diagrammatic illustration of the effect that a rise in ß

[11] Where $D_1 > 0$ is the same expression as (13), $D_2 = \Omega_{wL^{*}}\pi_{LL} - \Omega_{wL}\pi_{LL^{*}} > 0$, $D_3 = \Omega_{ww}\pi_{LL^{*}} - \Omega_{wL^{*}}\pi_{Lw} > 0$ and $D_4 = \Omega_{ww}\pi_{LL} - \Omega_{wL}\pi_{Lw} > 0$.

has on the endogenous variables, holding A and w^* constant. This is the downstream spillover in the presence of wage bargaining. We start from a symmetric equilibrium. Figure 4:4 shows the efficient bargaining solution, where firm 1's isoprofit and its union's indifference curve are tangential on the conditional demand for labour curve. The optimal condition for employment setting is also satisfied. Figure 4:5 shows the identical technologies of the two firms. A rise in the bargaining power of the union leads to a fall in the employment and output of firm 1. To a lesser extent it leads to a rise in the employment and output of firm 2. This shifts out the conditional labour demand curve in firm 2. To a lesser extent this leads to a inward shift of the conditional labour demand curve for in firm 1. The wage level rises in firm 1 as a result of the revised bargain. The union gets a bigger share of a smaller rent. The analysis of the upstream spillover due to wage bargaining is similar to the above. It will lead to a revised bargain in which there is a rise in the wage level in firm 1. In this case the union gets the same share of a bigger rent. It has the opposite effect on the conditional labour demand curves and market shares for the two firms.

We next examine the two-way spillovers in the limit of strong price competition. We work within the above framework but change the strategic variable of the firms. Firm 1 bargains with the union over the wage level while holding P and P^* constant. Simultaneous to the wage bargain, firm 1 (firm 2) unilaterally chooses P (P^*) to maximise $\pi(\pi^*)$, holding w (w^*) and P^* (P) constant. In the case where the outside option of firm 1 equals unit wage cost of firm 2 ($A = w^*$) the price that induces a Nash equilibrium is $P^e = A = w^*$. This is the symmetric equilibrium of the game.

Now we look at the comparative static effect of a change in ß and w^*. Rents in this model are driven to zero by the degree of price competition. A change in ß has no

effect on the market share or wage level. The downstream spillover due to the presence of wage bargaining is zero in the limit of strong price competition. A change in w^* represents an upstream spillover in the presence of wage bargaining. The only Nash equilibrium is for firm 2 not to enter the market. Hence firm 1 will share the monopoly rent with its workers. If firm 2 was to enter the market, firm 1 would set a price $A \leq w \leq P < w^*$. Any exogenous change in the product market in favour of firm 1 will cause market share and unit wage cost rise to their respective upper limit. Upstream spillovers due to the presence of wage bargaining are strongest in the limit of price competition.

We have examined the two-way vertical spillovers in the presence of wage bargaining under the assumption of either weak or extremely strong price competition. We formulate our general results as outlined in section I and summarise them in the following proposition.

Proposition 3: *The downstream (upstream) vertical spillover, due to wage bargaining, leads to a negative (positive) relationship between unit wage cost and market share performance in the product market. This becomes weaker (stronger) as we increase the intensity of price competition in the product market.*

III. The Empirical Evidence

By explicitly modelling the vertical spillovers that result from *imperfections* in both an upstream labour market and a downstream product market, we have a clear cut empirical agenda that discriminates between alternative theories of wage determination. We set out to find evidence for the presence of the downstream vertical spillover due to efficiency wage payments and wage bargaining[12]. To this end, we use our theory to constrain the data.

Our basic data source is an unbalanced panel of 993 large UK manufacturing companies over the period 1973-82 (see appendix A). Our theory relates to industries where goods do not have a vertical attribute. For this reason we exclude firms in R&D intensive industries. As in Sutton (1991), we expect market share to be mainly determined by a competitive escalation in R&D expenditures. We focus on firms that operate in relatively homogenous goods industries. To allow us to discriminate between the downstream vertical spillover due to efficiency wages and wage bargaining we split the data into high and low unionised samples. The criterion we apply is the median union density in 1979. Industries with lower than median density are grouped into a low unionised sample. The rest forms the high unionised sample. This is an attempt to constrain the data so that empirically we can pick up the downstream vertical spillover due to union activity in the high unionised sample and efficiency wage payments in the

[12] Vainiomaki and Wadhwani (1991) and Nickell et al. (1991), look for and find a positive relationship between unit wage cost and (instrumented) market share performance in a wage equation. Both papers suggest that this relationship is consistent with efficiency wage and bargaining theories of wage determination. From our theory, spillovers into wage determination from the upstream market can only be due to the presence of explicit or implicit wage bargaining. We take these papers as direct evidence for the existence of upstream vertical spillovers from market share to wage determination in the presence of wage bargaining.

low unionised sample. Yet, wage bargaining can still take place in the low unionised sample. The upstream spillover due to wage bargaining leaves us with an endogeneity problem in the market share equation which we control for in the estimation. The downstream spillover due to wage bargaining should be weakened considerable in the low unionised sample of firms that produce relatively homogenous goods. The average wage of the low unionised firms over the period 1973-1982 was very much in line with the high unionised sample. However wage dispersion is much greater in the low unionised sample and grows over the period analysed. The variance of the wage in the low unionised sample is 0.057 in 1973 and 0.078 in 1982. This compares for the high unionised sample with 0.025 in 1973 and 0.04 in 1982. Over the period 1973-1982, we hypothesize that in the low unionised sample, if a firm *voluntarily* paid out higher wages, relative to other firms in the industry, for efficiency wage reasons, this would induce a better market share performance. We also hypothesize that in the high unionised sample, if a firm *involuntarily* paid out higher wages relative to other firms in the industry, due to union activity, this would have a detrimental effect on its market share performance. These are testable propositions. The basic market share equation that we seek to estimate, is written down as the following.

$$(21) \qquad MS_{it}^{j} = FIX_{i}^{j} + \alpha_1 W_{it}^{j} + \alpha_2 SALES_{t}^{j} + \alpha_3 WEDGE_{t}^{j} + TIME_{t} + u_{it}^{j}$$

Where superscript j refers to the industry in which firm i belongs. MS_{it}^{j} is the market share of firm i in industry j in period t, FIX_{i}^{j} represents an unobservable firm fixed effect, W_{it}^{j} is the average wage in firm i belonging to industry j in period t, $SALES_{t}^{j}$ are industry j's total sales in period t and $WEDGE_{t}^{j}$ is the wedge between the retail and

wholesale price in industry j in period t. Industry sales and the industry wedge control for demand and supply shocks at the industry level. $TIME_t$ is an aggregate time effect which controls for aggregate shocks. u_{it}^j is a white noise error term.

A common feature of micro data is the presence of unobservable fixed effects (FIX_i^j), that are potentially correlated with the other explanatory variables. Ignoring them would yield inconsistent estimates. Using panel data allows us to difference these fixed effects out and to estimate the coefficients consistently. Obviously, this generates first order serial correlation in the error term. What matters is that the errors in the level equation are serially uncorrelated. This implies that second order serial correlation must be absent in the first difference form[13]. The method of estimation is the generalised method of moments technique (GMM), proposed by Arellano and Bond (1991). We use instrumental variables in the static model (21) because the wage is endogenous in the presence of wage bargaining. The advantage of GMM over other commonly used panel data estimation techniques, such as those proposed by Anderson and Hsiao (1981,1982), lies in the more efficient use of the available instruments. Arellano and Bond (1991) show that in a first difference model, valid instruments for endogenous variables are the levels of the endogenous variables dated t-2 and before. In other words, as the panel progresses, more instruments can be used. We wish to pick up the market share performance *induced* by unit wage cost i.e. the downstream spillovers from wage determination. It is therefore highly important to find valid instruments, thus a Sargan test of over-identifying restrictions is computed.

Table 1 reports the results. Columns (1) and (2) refer to the results for the low

[13] We shall use a test for serial correlation proposed by Arellano and Bond (1991), which is asymptotically N(0,1) distributed.

unionised sample, while column (3) refers to the results for the high unionised sample. For the two samples we report regressions for the period 1976-1982[14]. All specifications include time dummies to control for aggregate shocks. Specification (1) shows the results for the low unionised sample when estimating (21), the static equation. The wage is instrumented using all available moment restrictions on the wage and market share levels from t-3 backwards. However, the diagnostics indicate that this equation is misspecified, there is significant second order serial correlation and the Sargan test of instrument validity is rejected. To rectify this problem, specification (2) includes a lagged dependent variable. Since the model is estimated in first differences, the lagged dependent variable becomes endogenous and thus must be instrumented. We include the same instrument set as in specification (1) and they serve as instruments for the lagged dependent variable as well as for the wage. Column (2) shows a strong positive and significant effect of unit wage cost on market share performance. Both the second order serial correlation test and the Sargan test pass at conventional critical levels. This implies we are testing a clear causation between unit wage cost and market share performance. We take the positive wage effect as direct evidence that, over the period 1973-1982, in the low unionised sample, a subset of firms used high wages to *induce* a better market share performance. We see this as direct evidence that the high wage firms in this sample paid efficiency wages over this period.

Specification (3) reports the results for the high unionised sample. We estimate a static equation. The wage is instrumented using all available moment restrictions on the wage from t-3 backwards and the market share from t-2 backwards. In this case, the

[14] Since we used instruments dated t-3 and before, the regression starts in 1976 instead of 1973.

static equation fits very well. The diagnostics show that there is no second order serial correlation and the Sargan test indicates that the instrument set is valid. The effect of unit wage cost on market share is negative and significant at conventional levels. This is what one would expect in the presence of unions where the firms maintain the Right To Manage. Over the period 1973-1982, in the high unionised sample, the negative relationship between unit wage cost and market share performance implies that a subset of firms involuntary paid out high wages and this induced a deterioration in the market share performance of these firms.

Conclusion

We explicitly modelled the vertical spillovers that results from imperfections in both product and labour markets. In particular, the theory we developed tracked the vertical spillovers from wage determination to market share determination and vice versa. The theory predicted that efficiency wage payments create an unique downstream vertical spillover that leads to a positive relationship between unit wage cost and market share performance in the product market. The presence of wage bargaining was shown to drive a two-way vertical spillover. The downstream spillover due to the presence of wage bargaining leads to a negative relationship between unit wage cost and market share performance.

We set out to discriminate between the two downstream vertical spillovers. To this end, we used our theory to constrain the data. We split the data into a high and low unionised samples of large firms in relatively homogenous good industries. Over the period 1973-1982, exploiting the pooled cross sectional and time series dimension of our data set, we find evidence, in the low unionised sample, that firms voluntarily paid high wages to induce better market share performance. We take this as direct evidence that the high wage firms in this sample paid efficiency wages. We also find evidence, in the high unionised sample, that firms involuntarily paid high wages, which had a detrimental effect on their market share performance.

Figure 4:1

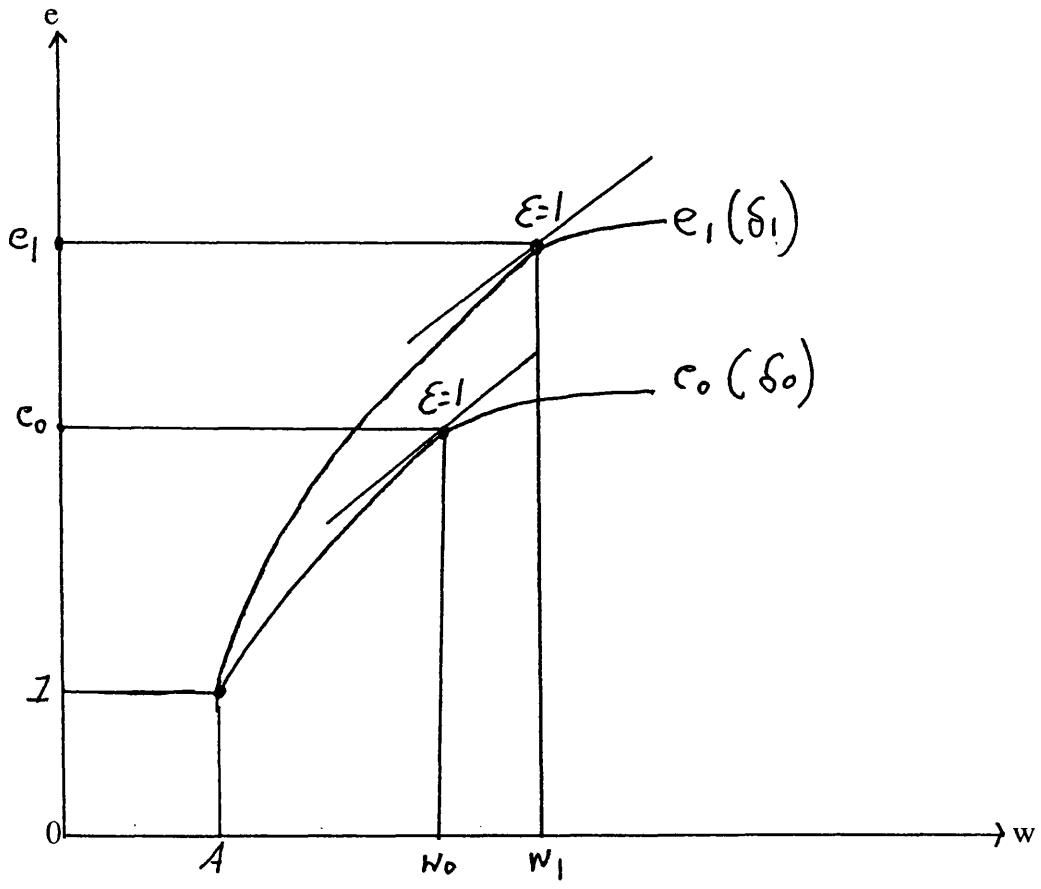
e
e_1
e_0
1
0
A
w_0
w_1
w
$\varepsilon=1$
$e_1(\delta_1)$
$\varepsilon=1$
$e_0(\delta_0)$

Figure 4:2

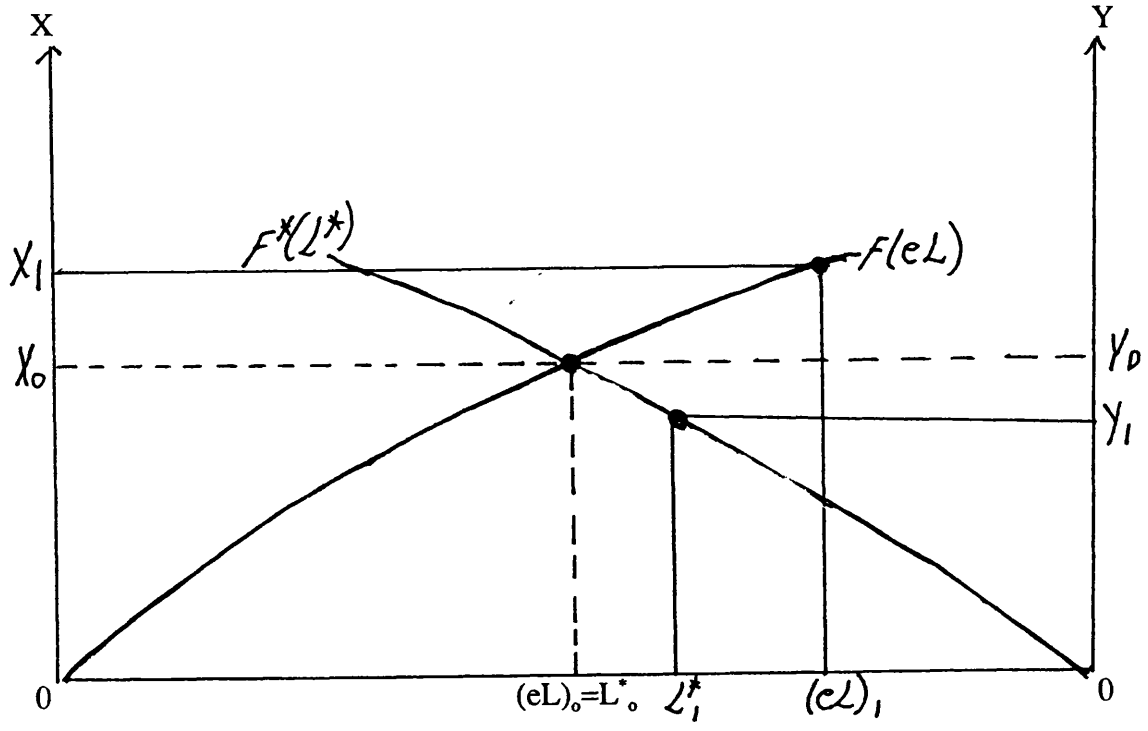

Figure 4:3

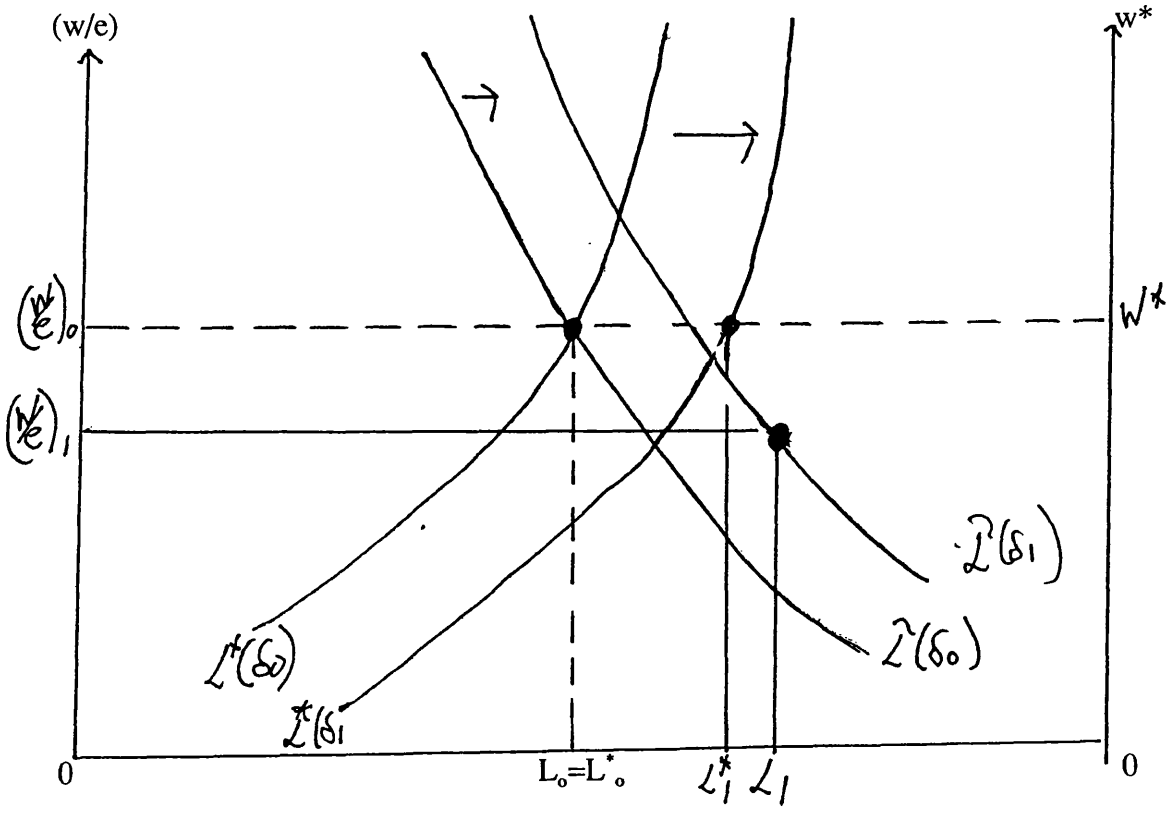

Figure 4:4

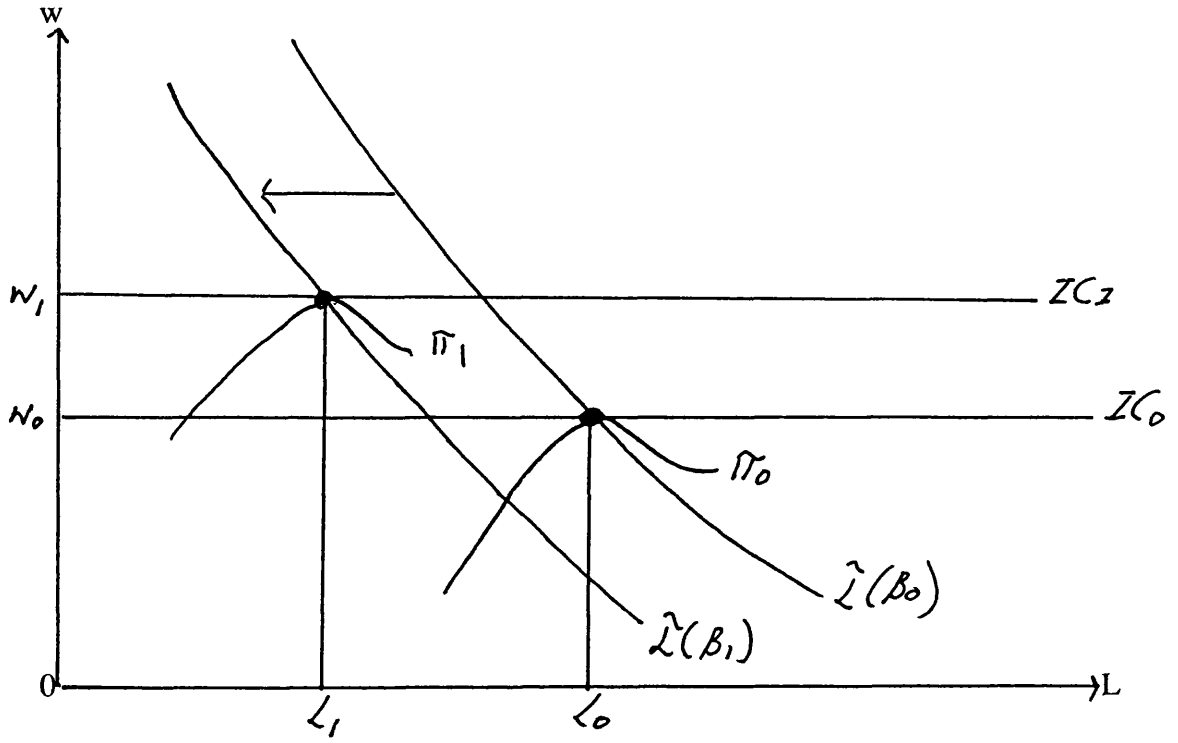

Figure 4:5

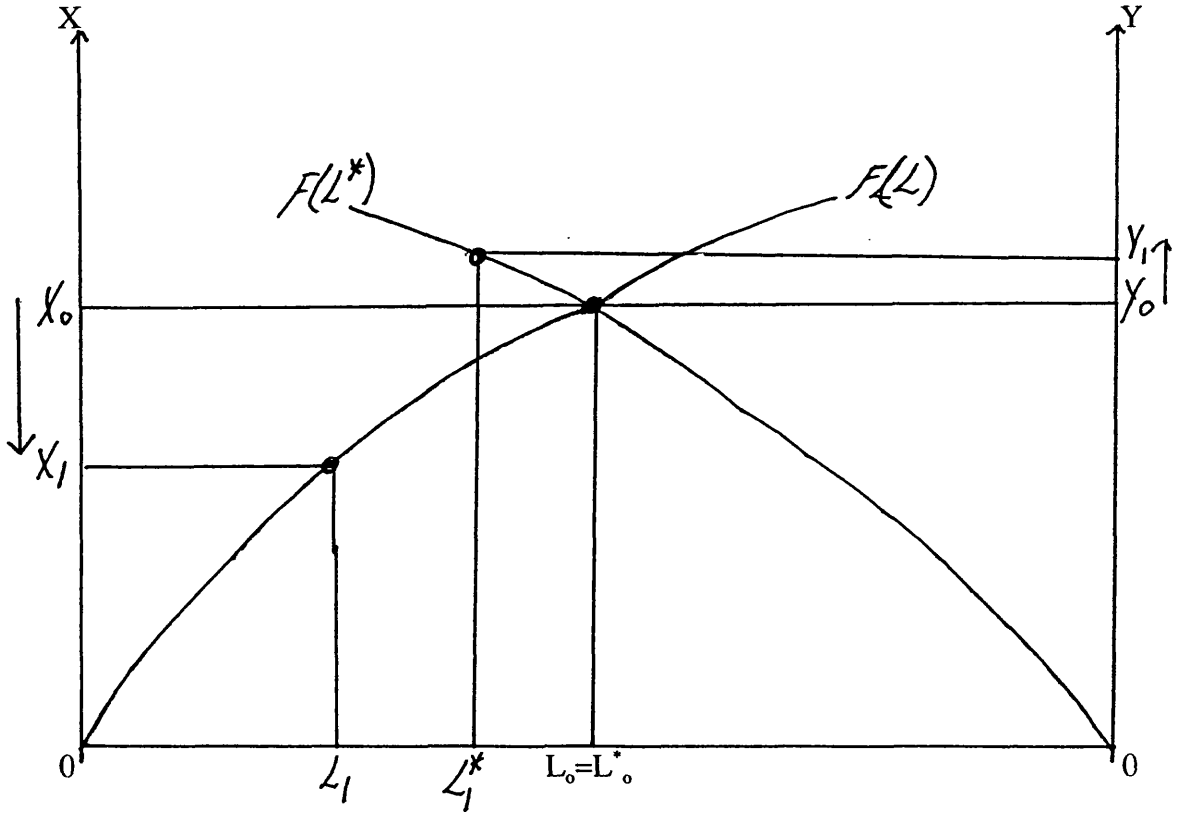

Table 4:1

Firm Level Market Share Equations, 1976-1982

Dependent Variable: Market Share

	Low Unionised Sample		**High Unionised Sample**
	(1)	(2)	(3)
MS_{it-1}	_	0.77 (25.3)	_
W_{it}	0.84 (8.96)	0.54 (3.34)	- 0.61 (- 6.34)
$SALES_t$	0.08 (2.23)	0.22 (4.94)	- 0.08 (- 1.27)
$WEDGE_t$	0.32 (3.45)	0.06 (0.88)	- 0.40 (- 3.02)
Time dummies	Yes	Yes	Yes
Number of firms	280	280	290
Sargan test	95.1(df=62)	79.72(df=61)	71.82(df=62)
SOC	2.24	-0.970	-0.240

====Notes:
(i) the package used is DPD, described in Arellano and Bond (1988)
(ii) coefficients are corrected for first order serial correlation and heteroscedastic consistent t-ratios are in parentheses.
(iii) the equations are estimated in first differences using instrumental variables, all variables are in logs. In (1), the wage is instrumented using all valid moment restrictions on the wage and the market share from t-3 back. In (2), the wage and the lagged market share is instrumented using all available moment restrictions on the wage and the market share from t-3 back. In (3), the wage is instrumented using all available moment restrictions on the wage from t-3 back and lagged market share from t-2 back.
(iv) the Sargan test is asymptotically Chi2 distributed, the degrees of freedom are in parenthesis and the second order serial correlation test (SOC) is asymptotically standard normal distributed.

Appendix A

The data was obtained by combining the EXSTAT data tape with the DATASTREAM on-line service.

Data(1):Firm Specific Variables: *Market Share*: Firm's sales divided by industry sales (EXSTAT measure, for details see Vainiomaki and Wadhwani (1991)). *Average Wage*: Domestic wage (EXSTAT item c16) divided by domestic employees (EXSTAT item c15) (for details see Vainiomaki and Wadhwani (1991)).

Data(2):Industry Specific Variables: *Industry Sales*: Census of Production. *Wholesale and Retail Prices*: Producer indices matched with Exstat industry groups. Trade and Industry until 1979, thereafter British Business. Wedge = log(Retail Price) - log(Wholesale Price). *Union Density*: Industry specific union density. The data were provided by S. Machin and J. Van Reenen.

List(1):Industries In The High Unionised Sample: Industrial Plant, Steel and Chemical plant, Wires and Rope, Misc. Mechanical Engineering, Machine Tools, Instruments, Metallurgy, Special Steels, Misc. Metal Forming, Household Appliances, Cutlery, Newspaper and Periodical, Publishing and Printing and Packaging and Paper.

List(2):Industries In The Low Unionised Sample:
Brick and Roof Tiles, Building Materials, Cement and Concrete, Floor Covering, Furniture and Bedding, Breweries, Wines and Spirits, General Food Manufacturing, Milling and Flour, Clothing, Cotton and Synthetic, Wool, Misc. Textiles, and Footwear.

Appendix B

If employment enters into the utility function of the union U(w,L), the employment that is set on the labour demand curve will not be an efficient outcome for the firm or the union. Both can do better by moving off the demand curve and setting wages and employment on the contract curve. This efficiency argument is made by Leontief (1946), Fellner (1947) and MacDonald and Solow (1981). Svejnar (1986), Eberts and Stone (1986) and Clark (1984) report evidence from the US and Dowrick (1989) from the UK that job bargaining does actually take place. We next outline a simple example of the downstream spillovers in the presence of wage and employment bargaining. The analysis of the upstream spillover is the same as outlined in section II under wage bargaining. The labour market is modelled within a generalised bargaining framework. The set-up for firms is exactly the same as in section II. The demand conditions we write down in the following form.

(A:1) $$P = 1 - Q : Q = X + Y$$

We introduce a union into firm 1. The union is modelled as being either risk averse ($\varepsilon < 1$), risk neutral ($\varepsilon = 1$) or risk loving ($\varepsilon > 1$). It maximises the following function in which the union gets utility from labour rent.

(A:2) $$U(w, L) = (w - A)^{\varepsilon}L$$

Under weak price competition firm 1 bargains with the union over the employment and wage level, holding L^* constant. Given (A:2), efficient contracts will lie off the labour demand curve. Simultaneously to the bargaining process, firm 2 unilaterally chooses L^* to maximise π^*, holding L constant, $L^* = R(L)$. To model *wage setting and employment setting* we express the generalised Nash product as the following and set A= 0.

(A:3) $$\Omega = w^{\varepsilon\beta}L^{\beta}\pi^{1-\beta}$$

To get the Nash bargaining solution we maximise (A:3) with respect to w and L, holding L^* constant. The first order conditions are expressed as the following:

(A:4)
$$\Omega_w = \varepsilon\beta/w + ((1-\beta)/\pi)\pi_w = 0$$
$$\Rightarrow w = R^*(L,L^*)$$

$$\Omega_L = \beta/L + ((1-\beta)/\pi)\pi_L = 0$$
$$\Rightarrow L = R^*(w,L^*)$$

The solution functions for the endogenous variables and the partial derivatives with respect ß can be obtained from the optimal response functions.

(A:5)
$$w^O = \Upsilon_1(\varepsilon, \beta) = \varepsilon\beta/D : w_\beta = 3\varepsilon/D^2$$
$$L^O = \Upsilon_2(\varepsilon, \beta) = 1/D : L_\beta = 2(1-\varepsilon)/D^2$$
$$L^{*O} = \Upsilon_3(\varepsilon, \beta) = (1-\beta(1-\varepsilon))/D : L^*_\beta = -(1-\varepsilon)/D^2$$

A rise in ß in our model is a rise in union bargaining power. In general it represents the downstream vertical spillover in the presence of wage and employment bargaining. The effect of a rise in union bargaining power on the employment level both in firm 1 and firm 2 depends on the risk preference of the union. It always causes the wage in firm 1 to rise. The rise is greater the bigger the preference put on the wage in the utility function by the union. If $\varepsilon=1$, there is no effect on employment and hence market share when union power increases. The effect on market share is negative if $\varepsilon > 1$ and positive if $\varepsilon < 1$.

Next we examine the downstream spillover in the limit of strong price competition. Firm 1 bargains with the union over the wage and price (employment) level holding P^* constant, to maximise (A:3). Simultaneous to the bargain, firm 2 unilaterally chooses P^* to maximise π^*, holding P constant. In the above case where the outside option of firm 1 equals the unit wage cost of firm 2 ($A = w^* = 0$), the price that induces a Nash equilibrium is $P^e = 0$. This is the symmetric equilibrium of the game. Now we look at the comparative static effect of a change in ß. This is the downstream spillover in the presence of wage and employment bargaining. Rents in this model are driven to zero by the degree of price competition. A change in ß has no effect on market share or the wage level set. The downstream spillover in the presence of wage and employment bargaining is zero under the limit of strong price competition.

In the above two simple models there is a general result emerging. We formulate our general results as outlined in section I. The downstream vertical spillover, due to wage and employment bargaining, can drive an non-monotonic relationship unit wage cost and market share performance in the product market. This becomes weaker as we increase the intensity of price competition in the product market. This indicates the possibility that a positive relationship between unit wage cost and market share performance in table 1 could be a result of bargaining over wage and employment levels in our low unionised sample.

We rule this out for three reasons. First, we are looking at homogenous goods industries where price competition is strong in our sample. The downstream spillover due to wage and employment bargaining is weak. Secondly, we split the sample into low unionised and high unionised firms. Wage bargaining may still be present in the absence of a union but employment bargaining needs collective action. Finally, in the unionised sample the downstream spillover is strongly negative and supports the assumption that unions put a bigger weighing on wages in their preferences.

CONCLUSION

The first three chapters apply the analysis of the interaction of product and labour market imperfections to the normative side of trade theory. In *chapter one* we recast the analyses of the old and new schools of international trade theory and show now they both build an endogenous trade divergence into their analysis. A trade divergence is modelled in the old school by allowing the home government to anticipate intra *home* industry competition in a foreign market and the detrimental effect it can have on home welfare. The home government levies a tax on each home firm to ensure that maximum rent is taken from the foreign market. The magnitude of intervention depends *positively* on the intensity of intra home industry competition in the foreign market.

A trade divergence is modelled in the new school by allowing the home government to anticipate *international* intra-industry competition in a foreign market and the detrimental effect it can have on home welfare. A subsidy for each home firm is optimal when the government anticipates *price support* and positive price cost margins ex-post intervention for each home firm. A restraint on home firm output becomes optimal when the government anticipates *price following* by foreign firms and positive ex-post intervention price cost margins for home firms. The magnitude of intervention in the new school depends *negatively* on the intensity of intra home industry competition in the foreign market.

We have shown that Cournot competition can be used to model both price support and high ex-post subsidy price cost margins for each home firm. We generalise the use of Cournot competition to represent *any* factor that leads to price support and high ex-post intervention price cost margins. In agriculture there is some form of price support (especially in EEC countries). There is also a fair rate of return guaranteed on

agricultural products ex-post intervention. These two simple factors explain why we observe governments giving subsidies to industries that produce agricultural products in industrialised nations.

We have shown that Bertrand competition can be used to model both price following by foreign firms and high ex-post tax price cost margins for each home firm. This analysis explains why governments, in a certain class of manufacturing export industries, voluntarily restrain the exports of home firms when they are guaranteed that foreign firms will price follow and high ex-post intervention price cost margins.

In *chapter two* we examined trade policy in the old and new schools of international trade theory under unionised intra-industry competition. We examined trade policy in the presence of a unionised international competition. The presence of union in a home exporting firm ensures that the home firm's wage bill includes a rent component. This social benefit of production should be included in social surplus as rent generated within an industry. We examine *export* policy in the absence and in the presence of international competition. In both cases, the optimal subsidy to an exporting home firm is negatively related to the intensity of intra-industry competition it faces and positively related to the bargaining strength of its union. The optimal subsidy is always positive when unionised intra-industry competition is weak and when union bargaining power is strong. Both of these conditions ensure that workers in the home exporting firm earn a high wage premium. This gives the home government a labour rent creation motive for trade policy. The government can increase social surplus by promoting the expansion of employment in high wage premium exporting firms. The more profitable the home exporting firm (due to weak intra-industry competition) and the more powerful the union in the wage bargaining process the more it can increase social welfare by

pulling employment into high wage premium exporting firms.

We also examined domestic policy in the absence and in the presence of international competition. Both a subsidy payment to a home firm or a tariff levy on a foreign firm are considered to be optimal policies. In the presence of imperfect intra-industry competition and wage bargaining, the best policy is always a subsidy payment to the home firm. The optimal subsidy would always bring industry output (even in the presence of unionised international intra-industry competition) to the socially optimal Bliss point. The tariff is a second best policy in the presence of unionised international intra-industry competition. The optimal tariff moves industry output to a level corresponding to that of a non-unionised monopoly firm operating in the domestic market. The optimal tariff appropriates the rent of a non-unionised monopoly to the home country in the guise of increased home firm rent, labour rent and tax revenue. The cost of this is a decrease in consumer surplus. In the presence of imperfect unionised international intra-industry competition, the appropriation of the monopoly rent to the home country using the optimal tariff, is a preferred option to free trade. The consumer gain under free trade does not compensate for the fall in home firm rent, labour rent and tax revenue. From society's point of view, free trade is the third best outcome. It allows foreign firms to exploit consumers and earn rent that is of no value to the home country.

In *chapter three* we examined export policy in the presence of imperfect intra-industry competition and efficiency wage payments. We looked at *export* policy in the presence and in the absence of international competition. A per unit of *output* subsidy can be optimal when the home government expects that intra-industry competition is weak and home workers, for efficiency reasons, receive a high wage premium. These conditions give the home government an incentive to increase social surplus by pulling

labour into home exporting firms that pay a high wage premium. There is a labour rent creation motive for export policy. A per unit of *labour* subsidy to home exporting firms paying efficiency wages is shown not to increase social welfare. This distinction between a product market and labour market subsidy did not arise in chapter two. The domestic and trade divergence are directly inter-linked in the presence of wage bargaining. Both a labour or product market policy instrument can be used to internalise the anticipated divergences. Katz and Summers (1989) where the first to examine the optimality of a labour subsidy in the presence of efficiency wage payments. They make a welfare argument that a labour subsidy should be to given to "sunrise" exporting industries as a policy to encourage employment in a high wage premium sector.

Their argument depends on the ability of worker's to extract rents as the demand for labour increases in response to the labour subsidy. This is not the case in our generalised efficiency wage model. We show that in response to a labour subsidy, the wage premium offered by the firm declines. The optimal labour subsidy has no effect on the output produced by home firms. The same output is produced with more labour and less effort. Product market rent remains unchanged. Labour rent also remains unchanged. Even though home firms are more labour intensive, the wage premium falls and ensures that overall the rent component of the wage bill is unchanged. This suggests that a labour subsidy that pulls employment into "sunrise" exporting firms does not increase welfare. There is no rent creation (firm or labour) motive for a labour subsidy in the presence of efficiency wages.

In *chapter four* we explicitly modelled the vertical spillovers that results from imperfections in both product and labour markets. In particular, the theory we developed tracked the vertical spillovers from wage determination to market share determination

and vice versa. The theory predicted that efficiency wage payments create an unique downstream vertical spillover that leads to a positive relationship between unit wage cost and market share performance in the product market. The presence of wage bargaining was shown to drive a two-way vertical spillover. The downstream spillover due to the presence of wage bargaining leads to a negative relationship between unit wage cost and market share performance.

We set out to discriminate between the two downstream vertical spillovers. To this end, we used our theory to constrain the data. We split the data into a high and low unionised samples of large firms in relatively homogenous good industries. Over the period 1973-1982, exploiting the pooled cross sectional and time series dimension of our data set, we find evidence, in the low unionised sample, that firms voluntarily paid high wages to induce better market share performance. We take this as direct evidence that the high wage firms in this sample paid efficiency wages. We also find evidence, in the high unionised sample, that firms involuntarily paid high wages, which had a detrimental effect on their market share performance.

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