Discussion Papers No. 502, April 2007
Statistics Norway, Research Department

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The Welfare Cost of Market Power
Accounting for Intermediate Good Firms

Abstract:
The market power of firms in intermediate good markets is found to generate a substantial welfare cost. Markup pricing of intermediate good firms contributes to increase the wedge between the marginal product of labor and the wage rate received by workers, as intermediate good firms add additional markups to the unit cost of a consumer good. This creates an additional wedge in the labor market, and is costly due to the existing substantial tax wedge in the labor market. The welfare cost of distortions in the supply of labor created by market power of firms is found to be more than 40 times larger than the welfare cost of distortions in the allocation of consumer goods created by differences in market power of firms. This welfare cost is substantial compared to previous estimates.

Keywords: Monopoly, Taxation, Welfare costs

JEL classification: D60, H20

Acknowledgement: I which to thank Brita Bye, Erling Holmøy, participants at the Nordic workshop on tax policy and public economics in Bergen; Nov. 2006, and other colleges at Statistics Norway for useful comments. I acknowledge grant from the Norwegian Research Council, Tax Research Program.

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1. Introduction

A series of studies has established that the welfare cost of market power is marginal. The well-known article by Harberger (1954) estimates that the welfare cost of distortions in the allocation of consumer goods due to market power amounts to about 0.3 percent of GNP in the US economy. Based on a series of later articles, Sherer and Ross (1990), assess the welfare cost to be between 0.5 and 2 percent of GNP. However, this literature has neglected to assess the welfare cost of distortions in supply of resources, in particular the effects on the supply of labor. Market power in product markets generates a wedge between the price of consumer goods and marginal costs and hence widens the wedge between the social marginal product of labor and the net of tax real wage received by workers. Such distortions are known to be costly due to the substantial tax wedge in the labor market. In fact, Browning (1997) found that the welfare cost from distortions in labor supply due to market power in product markets, is 5-15 times larger compared to the welfare cost created by distortions between consumer goods. Browning (1997), however, does not consider effects of market power possessed by intermediate good producers. Such market power generates a markup wedge between the price and the marginal cost of intermediate goods, which generates an additional wedge between the marginal product of labor and the real wage received by workers. Hence, the welfare cost of market power created by distortions in the labor supply is likely to be underestimated when the market power of intermediate good firms is omitted.

This paper contributes to the literature by calculating the welfare cost of market power in product markets in an economy where intermediate good firms and a share of the consumer good firms possess market power. The welfare cost of distortions in the supply of labor created by market power of firms is found to be more than 40 times larger than the welfare cost of distortions in the allocation of consumer goods created by differences in market power of firms. Hence, the welfare cost is substantial compared to previous estimates.

The magnitude of this welfare cost is to a large extent determined by the magnitude of the total wedge created in the labor market. The magnitude of this wedge is determined by the size of markup factors employed, and the magnitude of firms with market power. The wedge created by intermediate good firms consists of an accumulation of firm level markup factors. The markup factors are accumulated as the price of an intermediate good purchased by another intermediate good firm contains a markup factor. The flow of intermediate goods between intermediate good firms is substantial in industrialized countries, hence, a sequence of intermediate good firms have added a markup factor to the price of an

intermediate good that is purchased by a consumer good firm. This accumulation of firm level markup wedges generates a substantial wedge in the labor market, which contributes to explain the substantial welfare cost of market power found in this study.

The model in Browning (1997) is extended with intermediate good producers with market power. The production function of the two consumer goods is Leontief, where inputs are labor and an intermediate good. The production function of these intermediate goods is Leontief, where inputs are labor and another intermediate good etc. This production structure incorporates the effect where markup factors of intermediate good firms accumulate to a wedge in the labor market adding to effective taxes of labor income. The allocation of consumer goods is distorted by market power because only on of the goods is sold by firms with market power. All other aspects of the model are identical to the model in Browning (1997).

The welfare costs are found by calculating the area of the deadweight loss triangles created by market power. The welfare cost associated with distortions in the allocation of consumer goods consists of the area of the deadweight loss triangle in the product market diagram, which is equivalent to the "Harberger triangle". The welfare cost associated with distortions in the supply of labor consists of the area of the deadweight loss triangle in the labor market diagram that is created by market power. Sensitivity tests, however, shows that such welfare costs is sensitive to parameter values that are difficult to pinpoint due to uncertainty connected to empirical estimates. The welfare cost is more than doubled when the firm level markup factor or the compensated labor supply elasticity is doubled.

The findings in this study are likely to affect a series of tradeoffs in public policy. First, the optimal design of patent protection policy, see e.g. Nordhaus 1969, 1972, and Scherer, 1972, are based on a tradeoff between costs created by distortions due to market power, and gains connected to positive external effects associated with R&D activities, see e.g. Romer, 1990a, and Aghion and Howitt, 1992a. The welfare costs identified in this study is likely to alter this tradeoff, and hence, contribute to reduce the net welfare gain of patent protection policies. The welfare effects of a merger usually involves welfare gains connected to cost reductions, and welfare costs connected to creation of market power, see e.g. Saloner (1987). This study identify a welfare cost of market power previously neglected by the literature, hence, the net welfare gain of mergers are likely to drop due to this newly discovered welfare cost. The markup wedge identified in this study unveils a welfare cost of raising more tax revenue, as taxation is more costly with a larger total wedge in the labor market (see e.g. Goulder and Williams, 2003). The study also suggests that the welfare cost of intermediate goods

taxation is substantial. The firm level wedges created by intermediate goods taxation is likely to generate the same effects as the markup wedges, and hence, accumulate to a costly tax wedge on labor earnings.

Section 2 presents the model framework. The distortion in the allocation of consumer goods is analyzed in section 3, while section 4 analyzes the distortion created in the labor market. Some sensitivity tests are conducted in section 5. Section 6 concludes.

2. The model framework

The extent of market power varies among different industries and markets, depending on the structure of competition in the different markets. A common feature of these markets is that the price of products exceeds the marginal cost of producing these products. Market power in consumer good markets creates a wedge between the price and the marginal cost of these goods. Consumer goods, however, is produced by firms that use a substantial amount of intermediate goods. Market power in intermediate goods markets creates a wedge between the price and the marginal cost of an intermediate good, which constitutes an additional wedge between the price of the final good and the actual cost of producing the final good. Moreover, intermediate goods producers employ other intermediate goods in their production process. Market power in these intermediate good markets will generate an additional wedge between the price and the marginal cost of producing consumer goods. The massive flow of goods and services between firms implies that consumer goods are produced using a chain of intermediate goods. A chain of intermediate good producers with market power at every stage will create a chain of wedges that accumulates to a wedge between the price of a consumer good, and the marginal cost of producing this good. These features of market power are incorporated into the model presented below.

2.1 The model

There are to consumer goods produced in the economy, *X* and *Y*. The production function of the two consumer goods is Leontief, with inputs of labor and an intermediate good. The production function of these intermediate goods is also Leontief, with inputs of labor and another intermediate good etc. The production of intermediate good *i* is given by

$$x_i = \min\left[\frac{1}{\alpha} l_i, \frac{1}{1-\alpha} x_{i+1}\right], \tag{1}$$

where $i = 1,..,\infty$. x_{i+1} denotes the amount of intermediate good $i+1$ used in the production of intermediate good i, while l_i denotes the amount of labor used in the production of intermediate good i. The production of consumer goods is given by

$$x_j = \min\left[\frac{1}{\alpha} l_j, \frac{1}{1-\alpha} x_{1,j}\right], \tag{2}$$

for $j = X$ and Y. x_j denotes the amount consumer good j produced, and $x_{1,j}$ denotes the amount of intermediate good 1 used in the production of consumer good j. The unit cost of intermediate good i is given by

$$c_i = \alpha w_M + (1-\alpha) p_{i+1}, \tag{3}$$

where p_{i+1} denotes the price of intermediate good $i+1$, w_M denotes the wage rate paid to workers, and α is a factor that determines the share of wage costs. The intermediate goods are sold at a price that exceeds the unit cost by the same markup factor, M.

$$p_i = M + c_i \tag{4}$$

Equation (3) and (4) can be combined to form an infinite geometric series. After some manipulation, the geometric series can be written as

$$p_1 = \frac{M}{\alpha} + w_M \tag{5}$$

The unit cost, c, of producing consumer goods is identical since both goods are produced by the same technology.

$$c = \alpha w_M + (1-\alpha) p_1. \tag{6}$$

The price of consumer good X, p_X, exceeds the unit cost by a markup factor of M due to markup pricing, i.e.

$$p_X = M + c \tag{7}$$

The price of consumer good Y, p_Y, equals the unit cost, i.e.

$$p_Y = c \tag{8}$$

Inserting equation (5) and (6) into equation (7) and (8) gives

(9) $$p_X = \frac{M}{\alpha} + w_M$$

and

(10) $$p_Y = \frac{(1-\alpha)}{\alpha} M + w_M .$$

The wedges created between the price of consumer goods and the wage rate in equation (9) and (10) are generated by a sequence of markups added by intermediate good firms. The wedge in equation (9) is larger than in equation (10) because of the markup factor, *M*, added by producers of consumer good *X*, while there is no markup factor added by producers of consumer good *Y*.

2.2 Quantifying parameters in the intermediate good sector

A parameter value of α is chosen to generate a firm level cost share of intermediate goods, and hence, a cost share of labor, in line with empirical evidence. A broad based definition of intermediate goods is suitable in this study to include all inputs that is produced and sold by firms with market power. This definition should include material inputs, investments in real capital, transport costs and to some extent energy, as these input factors are goods produced and sold by firms. A rough estimate of the average value of α is found by dividing total wage payments on the gross production value reported in national accounts. This method suggests that the wage cost as a share of the unit cost in firms is approximately 1/3. Hence, α is set to 1/3, as the price of intermediate goods approximately equates the wage rate within the framework used. Note, however, that the cost of intermediate goods as a share of the unit cost is lower for intermediate goods further down the sequence of intermediate good firms. A sensitivity test is conducted in section 5.2 to illuminate on the effect of implementing other parameter values of α. Equation (9) and (10) becomes

(11) $$p_X = 3M + w_M$$

and

(12) $$p_Y = 2M + w_M$$

Equation (11) shows that the accumulated markup wedge between the price of consumer good *X* and the wage rate of the economy is three times larger than the firm level markup factor. Equation (12) shows that the accumulated markup wedge between the price of consumer goods *Y* and the wage rate of the economy is twice as large as the firm level markup factor.

The construction of intermediate good sectors within the model framework used generates a sequence of one-way deliveries of intermediate goods. This specification of sectors do not incorporate cross deliveries of goods and services between sectors, however, cross deliveries can be transformed into one-way deliveries by employing a more detailed specification of sectors, where each delivery of goods is originating from one sector. This choice of sectors capture the effects of markup pricing of intermediate good firms and at the same time simplify the calculations in this study.

The number of intermediate good firms involved in producing consumer goods is assumed to be infinite. This assumption can be justified by the substantial flow of intermediate goods and services between firms, and by the following numerical example. Assume that there are only three intermediate good firms involved in producing consumer good *X*, where the last good is produced by labor only. This generates a wedge of $\left[2+\frac{11}{27}\right]M$ between the price of consumer good *X* and the wage rate. Hence, the wedge created is almost as large as in the case with an infinite number of intermediate good firms. Consequently, assuming a sequence with an infinite number of intermediate good firms is not crucial for the wedge created.

3. The distortion in consumer goods

This section calculates the welfare cost of distortions in the allocation of consumer goods. It can be shown that the formal calculation to arrive at these costs and the magnitude of this type of welfare cost is identical to that found in Browning (1997). The welfare cost is identical because the market power of intermediate good firms does not alter the wedge created between the prices of consumer good *X* and *Y*. The wedge between these prices only consists of the firm level markup factor employed by producers of consumer good *X*, as the wedge generated by market power of intermediate good firms is identical for each consumer good.

The unit cost of the two consumer goods produced is determined by the markup factor and the wage rate in equation (11) and (12), hence the production frontier is linear. With suitable choice of units, the production frontier can be expressed as

(13) $$X+Y=100$$

Following Browning (1997), it is assumed that the monetary authorities keep total expenditures on both goods equal to 100. The demand functions are given by

(14) $$X = Cp_X^{-1}$$

and

(15) $$Y = (100 - C)\, p_Y^{-1}$$

C is a constant shift parameter determining the allocation of *X* and Y. These demand functions imply that

(16) $$p_X X + p_Y Y = 100\,.$$

Hence, the nominal GNP always equals 100[1]. These demand functions are suitable for this study because they facilitate interpretations of welfare costs since all figures will be given as a percentage of GNP. The subsequent price elasticities are in line with empirical estimates, see Gisser (1989) and Worcester (1975).

The wedge between consumer good *X* and *Y* is found by subtracting (12) from (11), i.e.

(17) $$p_X - p_Y = M$$

Solving the model numerically determines the magnitude of the effects of monopoly as a function of the degree (*M*) and extent (*C*) of monopoly power in the economy. Combining equations (14), (15) and (17) gives

(18) $$\frac{C}{X} - \frac{(100 - C)}{Y} = M$$

Inserting (13) into (15) gives

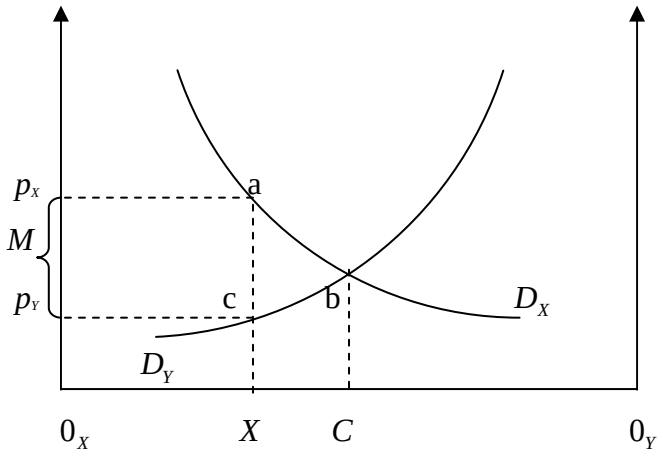
(19) $$MY^2 + 100(1 - M)Y + (100C - 10000) = 0$$

Inserting this solution for *Y* into (13) gives the expression for *X*.

The welfare cost of the product mix distortion is given by the Harberger-triangle depicted in figure 1. This triangle consists of the area denoted abc, between the demand curves denoted D_X and D_Y from the point of the market solution, *X*, to the point where the demand curves intersect, *C*.

[1] Note that GNP equals gross production value minus the value of intermediate goods, where gross production value equals sales of both consumer and intermediate goods.

Figur 1.



The expression for this triangle is

(20) $$W = \int_X^C (p_X - p_Y)\, dS \, .$$

inserting (13), (14) and (15) gives

(21) $$W = \int_X^C \left(\frac{C}{S} - \frac{(100 - C)}{(100 - S)} \right) dS \, ,$$

so that

(22) $$W = C \ln\left(\frac{C}{X} \right) + (100 - C) \ln\left(\frac{100 - C}{100 - X} \right).$$

Hence, the welfare cost of the product mix distortion is given for a given set of *C* and *M*. Following Browning (1997), the welfare cost as a percentage of GNP and the monopoly output, *X*, is reported for a set of parameter values of C and M in table 1. This welfare cost is below 0.3 percent of GNP when the firm level markup factor does not exceed 15 percent. The welfare costs in table 1 are identical to the welfare costs reported in Browning (1997), however, the welfare costs when the markup factor is 1 and 5 percent is also included.

Table 1. Welfare cost of output mix distortion (measured as a percentage of GNP)

M	0.01	0.05	0.1	0.15	0.2	0.25
C						
10	0.0004	0.011	0.041	0.087	0.147	0.219
15	0.0006	0.015	0.058	0.125	0.213	0.318
20	0.0008	0.019	0.074	0.160	0.273	0.410
25	0.0009	0.023	0.088	0.190	0.327	0.493
30	0.0010	0.026	0.099	0.217	0.375	0.568
35	0.0011	0.028	0.109	0.240	0.416	0.634
40	0.0012	0.030	0.116	0.258	0.450	0.689
50	0.0012	0.031	0.125	0.279	0.493	0.764
60	0.0012	0.030	0.123	0.279	0.499	0.784

Produced quantity of X

M	0.01	0.05	0.1	0.15	0.2	0.25
C						
10	9.91	9.57	9.17	8.80	8.45	8.13
15	14.87	14.38	13.81	13.27	12.77	12.30
20	19.84	19.22	18.49	17.80	17.16	16.55
25	24.81	24.09	23.22	22.39	21.61	20.87
30	29.79	28.97	27.98	27.04	26.14	25.28
35	34.77	33.88	32.80	31.75	30.74	29.77
40	39.76	38.81	37.65	36.52	35.42	34.36
50	49.75	48.75	47.51	46.27	45.05	43.84
60	59.76	58.79	57.56	56.31	55.05	53.79

4. The distortions in the labor market

4.1 Calculating the deadweight loss

The welfare costs created by distortions in the supply of labor is found by calculating the change in the deadweight loss triangle in the labor market when markup factors are removed. Following Browning (1997), it is assumed that both consumer goods possess the same degree of substitutability for leisure (see Parry, 1994 for a formal treatment). This assumption simplifies the calculations because the distortion in the supply of labor created by markup pricing is determined by the wedge between the average marginal product of labor and the pre tax wage rate paid to workers. This wedge equals the

sum of the accumulated markup wedges between the price and the unit cost of the two products, weighted with their respective market shares, $3M\frac{X}{100}+2M\frac{Y}{100}$, which equals $\frac{MX}{100}+2M$ when (13) is inserted. The expression for the wedge is found by multiplying (11) with *X* and (12) with *Y*, and summing these equations and inserting (16). This gives

(23) $$\frac{p_X X + p_Y Y}{100} = 1 = \frac{MX}{100} + 2M + w_M$$

The first and second term on the right hand side of equation (23) amounts to the wedge created by market power. The last term, w_M, equals the pre tax wage rate paid to workers. The left hand side of equation (23), which equals unity, amounts to the average marginal product of labor when the supply of labor is normalized to 100. This follows as the numerator on the left hand side of (23) equals GNP (which equals 100) and because the production structure within the framework used can be reduced to an aggregate production function with a constant unit cost where labor is the only input factor. Hence, the wedge created by market power equals

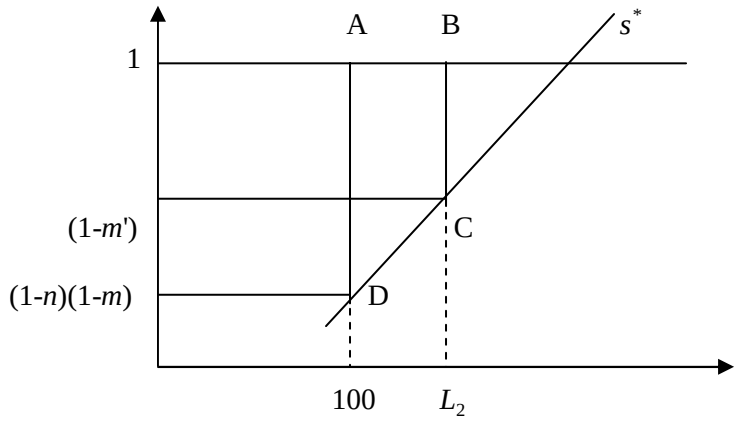
(24) $$n = \frac{MX}{100} + 2M \ .$$

This markup wedge equals the monopoly profit as a share of GNP. The first term on the right hand side is due to markup pricing in the consumer good sector, and the last term is due to markup pricing in intermediate good markets. Browning (1997) only incorporates the first term, and hence, implements a smaller wedge in the labor market. Implementation of this smaller wedge explains the smaller welfare cost of market power found in Browning (1997).

The welfare cost of market power in product markets is illustrated in figure 2. A market solution with the markup wedge included is compared with a market solution where the markup wedge is removed. Equations (23) and (24) imply that the pre tax wage rate paid to workers, w_M, equals $(1-n)$ when the markup wedge is included. Income is assumed to be taxed with a rate of *m*. Hence, the after tax net wage rate confronting workers, w_N, equals (1-*n*)(1-*m*). The labor supply is normalized to 100. When the markup wedge is removed and all other variables are kept constant, the after tax wage rate equals $(1-m)$. This results in an increase in tax revenues, as both the tax base (*L*) and the wage rate w_M increases. Following Browning (1997), it is assumed that the tax revenue is fixed to the level prior to the removal of the markup wedge, hence, the tax rate on income can be reduced to m', and the after tax

net wage rate becomes $(1-m')$ with a subsequent labor supply of L_2. The welfare cost of market power generated by distortions in the labor market is given by the area ABCD in figure 2.

Figure 2.



The calculation of the welfare cost is closely related to the calculation in Browning (1997). The compensated labor supply curve (s^* in figure 1) is given by

(25) $$L = \mu + \beta w_N$$

The supply curve is calibrated so that the labor supply equals 100 when $w_N = (1-m)(1-n)$. The labor supply elasticity is given by $\frac{\beta w_N}{L} = \eta$ when L = 100.

Hence,

(26) $$\mu = 100 - \beta(1-m)(1-n)$$

and

(27) $$\beta = \frac{100\eta}{(1-m)(1-n)}.$$

The labor supply curve is determined for given values of *m*, *n* and η.

4.2 Quantifying parameters connected to market power

The magnitude of monopoly profit as a share of GNP is determined by the extent, *C*, and degree, *M*, of market power. The parameter values of these variables should be chosen in line with empirical observations. However, the magnitude of monopoly profit should be interpreted within the context of the framework used.

Empirical estimates of the price-cost margin of firms classified as firms with market power, $p_i - c_i / p_i$, are found to be around 10 percent, while price-cost margins in excess of 15 percent are rare (see Scherer and Ross, 1990, and Worcester, 1975)[2]. Inserting $M = 0{,}1$ into equation (24) results in a monopoly profit of at least 20 percentage of GNP. However, Scherer (1980) finds that pure profit only amounts to 2-3 percent of GNP for the US economy. Consequently, it does not seem to be feasible to implement a firm level markup factor in line with empirical observations that generates a monopoly profit as a share of GNP that are in line with empirical observations of pure profits as a percentage of GNP. However, the model framework used do not incorporate entry costs or variable unit costs. A market solution where the monopoly profit in excess of entry costs amounts to 2-3 percent of GNP is consistent with the size of markup factors found in the empirical literature when most of the monopoly profit generated cover fixed entry costs. Such a cost structure is observed in many sectors of the economy. This cost structure is not incorporated into the model framework used, however, two alternative approaches generates results that are consistent with such a cost structure.

The first approach assumes that the firm level markup factors are constrained to those generating a monopoly profit of 2-3 percent of GNP. Such a constraint is incorporated into the study of Browning (1997), however, his study only incorporate monopoly profit from consumer good firms. The constraint on pure profit together with equation (24) imply that the firm level markup factor, *M*, is lower than 0,015. The welfare cost of market power is calculated for the case where the firm level markup factor equals one percent, $M = 0{,}01$, which generates a monopoly profit of 2-3 percent of GNP. The second approach consists of calculating the welfare cost of market power for a range of firm level markup factors, including those found by the empirical literature. However, the removal of market power is implemented by setting prices equal to unit costs. This price setting strategy implies negative pure profit for firms facing entry costs. Such a solution does not represent a sustainable market solution, and hence, should be interpreted as a social planner solution. Consequently, the welfare cost derived using this approach should be interpreted as welfare costs from a social planners

[2] The markup factor, M, in this study only constitutes the numerator of the price-cost margin, however, it is a good approximation for the price-cost margin within this model.

point of view. The welfare costs derived do not represent an estimate where market solutions are compared.

The first approach seems to be relevant for the case where output within firms are constant, and removal of market power leads to entry of firms with a zero pure profit margin. A constant output within firms imply that the firm level markup factor is irrelevant as a measure of the industry level wedge created by market power. However, this approach is not satisfactory when removal of market power increases the output of firms, and reduces the incentive of firms to enter an industry. The second approach seems to be more tractable when the removal of market power is likely to generate an expansion of output within firms, while the number of firms is fixed. The procedure used to calculation the welfare cost of market power is identical within both these approaches. The two approaches differ only with respect to the size of markup factor employed. This study calculates the welfare cost of market power for a range of firm level markup factors, and hence, incorporates values consistent with both these approaches.

The aim of this study is to quantify the welfare cost of market power possessed by consumer and intermediate good firms. The study do not assess to what extent market power is necessary or even desirable as a tool to promote and secure entry of firms. The main result of this study holds within a range of markup factors. Consequently, the range of markup factors employed is not constrained to those generating a monopoly profit as a percentage of GNP that are equal to empirical observations of pure profit as a percentage of GNP.

The magnitude of consumer good firms engaged in markup pricing is to a large extent determined by the parameter value of C. Empirical studies show that price-cost margins vary among firms and industries. The price of goods and services supplied by the public sector is not likely to incorporate a markup factor. In fact, many of these goods and services are sold at a price below their unit cost. Consequently, it is not obvious which parameter values that should be attached to C. The welfare cost of market power is calculated for a range of parameter values of C, which together with M determines the amount of consumer goods, X, sold at a price including a markup factor.

4.3 Distortions when all income is taxed

The framework used suggests that both monopoly profit and labor income should be included in the tax base. First, monopoly profit is likely to be taxed by corporate income taxation in most tax systems. Second, when the monopoly profit pays for entry costs, which are not included in the model, this profit

is likely to appear as income elsewhere in the economy. These features are incorporated into the model by assuming that the tax rate on labor income is identical to the tax rate used to tax monopoly profit. The government budget requirement state that

(28) $mL = m'L_2$,

where m' is the tax rate when the market power is removed.

Equation (28) combined with the labor supply curve

(29) $L_2 = \mu + \beta(1 - m')$,

determines L_2 and m'. Inserting for L_2 in (29) gives

(30) $\beta(m')^2 - (\mu + \beta)m' + mL = 0$

The solution of equation (30) is inserted into equation (29), to determine L_2. These solutions determine the welfare cost of market power for a given set of values of *m*, *n* and η. The expression for the welfare cost of market power is found by employing the formula for the area ABCD that marks the welfare cost in figure 2, and implementing values found by the formulas above. The welfare cost is then given by

(31) $W^* = 0.5(m + m' + n - mn)(L_2 - 100)$

The initial tax wedge, *m*, equals 0.43. The compensated labor supply elasticity, η, equals 0,3. These parameter values are identical to the parameter values used in Browning (1997), which are chosen based on a discussion in Browning (1987). Sensitivity tests of parameter values are conducted in section 5. Monopoly profit as a share of GNP, n, is determined when the degree (*M*) and extent (*C*) of market power is given. The welfare cost is calculated for a range of parameter values of *C* and *M*.

Table 2. The Welfare cost created by distortions in the supply of labor (measured as a percentage of GNP). Uniform taxation of all income.

M	0.01	0.05	0.1	0.15	0.2	0.25
C						
10	0.361	2.085	5.017	9.179	15.219	24.320
15	0.369	2.142	5.173	9.504	15.839	25.485
20	0.378	2.200	5.332	9.841	16.490	26.731
25	0.386	2.258	5.496	10.190	17.176	28.065
30	0.395	2.317	5.663	10.553	17.899	29.497
35	0.403	2.377	5.835	10.931	18.663	
40	0.412	2.437	6.012	11.324		
50	0.430	2.561	6.379			
60	0.448	2.688	6.767			

Table 2 shows that the welfare cost is substantial. When the firm level markup factor is 0.1 and *C* is 40, the welfare cost is 6.0 percent of GNP. These substantial costs are a result of the substantial wedge created by market power in the labor market (see equation (24)). The markup wedge is removed when the market power is removed. The removal of market power also contributes to reduce the tax wedge in the labor market. The tax wedge is reduced because the tax base is effectively extended when the market power is removed as the supply of labor is increased. The welfare cost of product mix distortions in table 1 is marginal compared to the welfare cost of the labor supply distortion in table 2.

4.4 Distortions when all income is taxed, and labor income taxation is progressive

Most tax systems consist of a progressive taxation of labor income. A progressive taxation of labor income will affect the relationship between the wedge in the labor market, and the amount of tax revenue generated. A change in this relationship is likely to affect the welfare cost of removing the market power in product markets. The welfare cost is affected as the subsequent change in the tax rate to preserve tax revenue is altered. This section incorporates progressive taxation of labor income. Following Browning (1997), the progressive tax system is incorporated as a flat tax rate on labor income in excess of an exemption. In contrast to Browning (1997), the same flat tax rate is incorporated on all monopoly profit. Let *E* be the supply of labor that is effectively exempted from taxation, the equal revenue requirement is given by

$$nLm + m(1-n)(L-E) = m''\left(L_2'' - E\right), \tag{32}$$

where m'' is the tax rate when the market power is removed and L_2'' is the supply of labor. Hence,

(33) $$(L-E)m+nmE=m''\left(L_2''-E\right).$$

The rest of the equations are unchanged. The tax rate on monopoly profit and labor income from labor supply above *E* is set to 0.43, where the parameter value for E of 28 is taken from Browning (1997). The welfare cost is reported in table 3.

Table 3. The Welfare cost created by distortions in the supply of labor (measured as a percentage of GNP). Progressive taxation of labor income

M	0.01	0.05	0.1	0.15	0.2	0.25
C						
10	0.290	1.738	4.363	8.299	14.237	23.385
15	0.297	1.788	4.506	8.613	14.855	24.563
20	0.304	1.837	4.654	8.940	15.506	25.823
25	0.311	1.888	4.805	9.279	16.192	27.173
30	0.318	1.939	4.961	9.633	16.917	28.623
35	0.325	1.991	5.121	10.002	17.683	
40	0.332	2.044	5.286	10.386		
50	0.347	2.152	5.630			
60	0.361	2.264	5.995			

These results show that the welfare cost is still substantial. The welfare cost of labor supply distortions is between 4.3 and 6.0 percent of GNP, when the markup factor at the firm level is 10 percent. The welfare cost is slightly lower compared to the case with proportional taxation since the removal of market power leads to a smaller tax rate reduction in the case with progressive taxation. The tax rate reduction is smaller because the removal of market power increases the pre tax wage rate. The increased pre tax wage rate contributes to increase the amount of untaxed labor income and the tax rate required to preserve the tax revenue is higher. Hence, removal of market power in the case with progressive taxation generates a slightly smaller welfare gain compared to the case with uniform taxation. Browning (1997) reports an increase in the welfare cost of monopoly power due to progressive taxation of labor income. However, his study exempt taxation of monopoly profit and this explain the difference in results.

When the progressive tax system is introduced by taxing monopoly profit and labor income with the same rate, and subtracting a fixed amount of labor income from taxation, where the same amount is subtracted when the market power is removed, the government budget constraint becomes identical to the case with proportional taxation. Hence, the welfare cost of market power would be identical to the case with proportional taxation in such a system.

4.5 Distortions when monopoly profit is taxed with a lower rate

The effective tax rate of capital income is lower than the effective tax rate on labor income in most countries. Removal of market power will extend the labor income tax base at the expense of the monopoly profit tax base. This effect contributes to increase tax revenue collected by the governments in the case where labor income is taxed with a higher rate than capital income. Hence, this effect contributes to lower the tax rate on labor income when tax revenue collected is preserved and market power is removed. Consequently, the welfare cost of market power is likely to be larger in this case. The welfare cost of market power is calculated in a case where the tax rate on monopoly profit is set to zero to quantify the maximum potential welfare cost of market power in a setting with a lower tax rate on capital income. The government budget constraint is altered to

$$m(1-n)L = m'''L_2''' , \tag{34}$$

where m''' is the tax rate when the market power is removed and L_2''' is the supply of labor.

The subsequent supply of labor is given by

$$L_2''' = \mu + \beta(1-m''') . \tag{35}$$

The government budget requirement, (34), and the labor supply curve, (35), determines L_2''' and m'''. Note that the initial labor supply, L, equals 100. By inserting for L_2''' from (35) into (34) gives

$$\beta(m''')^2 - (\mu+\beta)m''' + m(1-n)L = 0 . \tag{36}$$

The value of m''' that solves this equation is inserted into the labor supply curve, (35), to determine L_2'''. The welfare cost of market power due to distortions in the labor market is determined by the same procedure as in section 4.1. Results are reported in table 4.

Table 4. The Welfare cost created by distortions in the supply of labor (measured as a percentage of GNP). Monopoly profit exempted from taxation

M	0.01	0.05	0.1	0.15	0.2	0.25
C						
10	0.620	3.302	7.239	12.183	18.760	28.118
15	0.634	3.384	7.434	12.551	19.413	29.292
20	0.648	3.467	7.633	12.929	20.095	30.542
25	0.662	3.551	7.836	13.320	20.811	31.878
30	0.677	3.636	8.043	13.724	21.562	33.308
35	0.691	3.721	8.255	14.142	22.351	
40	0.706	3.807	8.471	14.574		
50	0.736	3.982	8.916			
60	0.766	4.160	9.381			

When the firm level markup factor is between 0,1 and 0,15, the welfare cost spans from 7.2 to 14.6 percent of GNP when the extent of monopoly in the consumer good sectors (C) is below 40. The minimum welfare cost when the firm level markup factor is only 5 percent, is 3.3 percent of GNP.

When the firm level markup factor equals 10 percent and C equals 40, the welfare cost equals 6.0 percent of GNP with uniform taxation of all income, and approximately 8.5 percent of GNP when monopoly profit is exempted from taxation. When the market power is removed in the case where monopoly profit is untaxed (table 4), the tax base is effectively extended to all income, as the untaxed monopoly income is removed. This extension of the tax base contributes to reduce the tax rate required to preserve tax revenue when the market power is removed. The removal of market power also leads to a higher pre tax wage rate, which also contributes to reduce the tax rate needed to preserve tax revenue. The reduction in the tax rate contributes to generate a welfare gain, as the wedge in the labor market is reduced. This effect contributes to increase the welfare cost of market power, as more is gained by removing the market power. When the market power is removed in the case where all income is taxed (table 2), the tax base is not effectively extended to all income, as monopoly income is already taxed in this case. Hence, the tax rate reduction required to preserve tax revenue when market power is removed is smaller in this case. Hence, the welfare cost of market power is smaller in the case where all income is taxed. An alternative intuition for this result is that the welfare cost of market power is smaller in the case where all income is taxed, because taxation of monopoly profit does not distort the economy. Browning (1997) finds similar effects of introducing taxation of

monopoly profit. The welfare cost of monopoly power is approximately halved when taxation of monopoly profit is included in his study.

The welfare costs of the labor supply distortion in Browning (1997) are reported in table 5. These welfare costs are equivalent to a case where intermediate good firms do not possess any market power, and sell products at unit cost.

Table 5. The Welfare cost created by distortions in the supply of labor (measured as a percentage of GNP). Monopoly profit exempted from taxation. Market power only in consumer good firms

M	0.01	0.05	0.1	0.15	0.2	0.25
C						
10	0.027	0.140	0.270	0.389	0.500	0.602
15	0.040	0.211	0.408	0.590	0.760	0.918
20	0.054	0.283	0.547	0.795	1.026	1.243
25	0.068	0.355	0.689	1.004	1.301	1.580
30	0.082	0.428	0.834	1.218	1.583	1.929
35	0.096	0.501	0.980	1.438	1.874	
40	0.110	0.575	1.129	1.662		
50	0.139	0.724	1.434			
60	0.169	0.876	1.750			

A comparison of table 5 and table 4 shows that the welfare cost of market power possessed by intermediate good firms is substantial compared to the welfare cost without market power possessed by intermediate good firms. When e.g. the markup factor equals 0.1 and C equals 40, the welfare cost is 7.5 times larger when there is market power possessed by intermediate good firms. These results suggest that the literature has seriously underestimated the welfare cost of market power in product markets.

5. Sensitivity tests

The choice of parameter values in this study is based on rough estimates that are implemented into a simple model framework. These estimates can be criticized for being uncertain, and hence, that the welfare costs derived in this study is based on uncertain parameter values. Some of the uncertainty is connected to the interpretation of the parameters in the simplified framework used. The effect of uncertain parameter values is analyzed by conducting a series of sensitivity tests. The subsequent

sensitivity tests are conducted in a base line scenario where all income is taxed by 43 percent, the markup factor (*M*) equals 0,1, and C equals 40.

5.1 The tax wedge in the labor market

The initial tax wedge in the labor market is crucial for the determination of the welfare cost of market power. The quantification of this wedge requires some discussion, as the simple framework used excludes some important factors. The previous sections assume that the initial tax wedge in the labor market equals 0.43, which is the main parameter value used in Browning (1997). His choice of parameter value is based on a discussion in Browning (1987). Browning (1997) also present a case where the initial tax rate is increased to 0.5, as factors like non-violent crimes against businesses, union power, international trade restrictions, pollution control and federal regulations of businesses constitute a wedge of around 15 percent of the wage rate in the US economy, see Browning (1994). On the other hand, rivalry related to preference for relative consumption, Frank (2005), and unforeseen habits of consumption, contributes to expand the supply of labor. Layard (2002) argues that the tax rate on labor income should be 60 percent to correct for these distortions. Negative external effects connected to pollution may also justify some indirect taxation of consumption, and hence, reduce the supply of labor. Also, the welfare cost connected to distortions in the supply of labor is likely to be traded for welfare gains connected to redistribution of income from rich to poor. Such gains are not included into the simple framework used in this study. The arguments above suggest that a sensitivity test is needed to incorporate an initial tax rate that covers these aspects.

When the initial tax rate, *m*, is increased by 10 percentage points from 43 to 53 percent, the welfare cost of market power due to distortions in the labor market increases from 6.0 to 8.4 percent of GNP. When the initial tax rate is reduced to 33 percent, the welfare cost is reduced to 4.4 percent of GNP. When the initial tax rate is set to only 10 percent, the welfare cost is reduced to 2.0 percent of GNP. The initial effective tax wedge on labor income is clearly a crucial parameter for the welfare cost of market power, as in Browning (1997).

5.2 The extent of market power in intermediate good markets

The calculations in the previous sections assume that all intermediate goods firms possess the same degree of market power. This assumption generated a wedge in the labor market equivalent to *n* in equation (24). However, the empirical justification for this assumption, and the rough estimate of the wage share, α, suggest that (24) should be interpreted as a rough estimate. A sensitivity test is conducted to illuminate on the case where the extent of market power in intermediate good firms is

reduced. When the extent of market power is reduced by increasing α to ½ , the wedge created in equation (24) is changed to

(37) $$n'' = \frac{MX}{100} + M$$

This new wedge leads to a welfare cost of 2.9 percent of GNP. The estimate given in section 4.3 is 6.0 percent of GNP. Hence, lowering the accumulated markup wedge reduces the welfare cost of market power.

On the other hand, the extent of market power might be underestimated in the previous sections. First, firms sometimes operate with excess capacity due to e.g. a recession in the economy. The excess capacity implies that the cost of producing an extra unit becomes marginal from a social planners point of view. Consequently, the markup factor between the price and the unit cost becomes substantial in this situation. Second, the price of a product in equation (4) was found by adding a markup factor, *M*, to the unit cost. However, a change from additive to proportional markup pricing changes equation (4) to

(38) $$p_i = (M+1)c_i$$

When α equals 1/3, and *M* equals 0.1, the price of the final product, *X*, becomes 1.375*w*. Hence, the accumulated markup factor is almost 4 times larger than the firm level markup factor, while the accumulated markup factor is 3 times larger in equation (11). A sensitivity test of a case where the wedge in equation (24) is replaced by

(39) $$n''' = \frac{MX}{100} + 3M \ ,$$

shows that the welfare cost of labor market distortions amounts to 10.4 percent of GNP. The extent of market power in intermediate goods firms is clearly a crucial factor for the welfare cost of market power.

5.3 The labor supply elasticity

The previous sections assume that the compensated labor supply elasticity, η , equals 0,3. However, different empirical studies report different elasticity's. A sensitivity test shows that the labor supply elasticity is a crucial parameter for the welfare cost of market power.

Table 6. The Welfare cost created by distortions in the supply of labor (measured as a percentage of GNP) for different elasticity's

The compensated labor supply elasticity, η	0.1	0.2	0.3	0.4
The welfare cost of market power	1.7	3.7	6.0	8.7

6. Conclusion

This study quantifies the welfare cost of market power in product markets. Previous studies have neglected to consider crucial features of market power possessed by intermediate goods firms. The market power possessed by intermediate good firms contributes to increase the wedge between the marginal product of labor, and the wage rate received by workers. The welfare cost generated by this increase is substantial due to a large initial tax wedge in the labor market. The welfare cost of market power created by distortions in the supply of labor is found to be more than 40 times larger than the welfare cost of distortions in the allocation of consumer goods created by differences in market power of firms. The welfare cost of market power possessed by consumer good firms created by distortions in the supply of labor is found to be 5-15 times larger than the welfare cost created by distortions in the allocation of consumer goods in Browning (1997). Browning (1997), however, does not consider market power possessed by intermediate good producers, and hence, neglects to incorporate the wedge created by market power of intermediate good firms. This study shows that the welfare cost of market power is substantial compared to previous estimates.

Market power in product markets is likely to generate both costs and gains that are not considered in this study. Costs connected to rent-seeking behavior to capture a monopoly profit, or costs connected to slack or x-inefficiency within monopoly firms, are not considered. Such costs contribute to increase the welfare cost of market power. However, monopoly profit is a crucial incentive for R&D activities, and hence, innovations within the private sector (see Schumpeter, 1934). Gains connected to such activities are not considered in this study. The study was confined to assess the welfare cost created by distortions in the allocation of consumer goods, and in the supply of labor.

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