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A SURVEY OF THE EFFECTS OF THE MINIMUM WAGE ON PRICES

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Abstract

It is well established in the literature that minimum wage increases compress the wage distribution. Firms respond to these higher labour costs by reducing employment, reducing profits, or raising prices. While there are hundreds of studies on the employment effect of the minimum wage, there are merely a handful of studies on its profit effects, and only a couple of dozen studies on its price effects. Furthermore, a comprehensive survey on minimum wage price effects is not available in the literature. Given the policy relevance of this neglected issue, in this paper we summarise and critically compare the available evidence on the effects of minimum wages on prices.

Keywords: minimum wage, employment, labour costs, cost shock, pass-through.

JEL code: J38.

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1 Introduction

It is well established in the literature that minimum wage increases compress the wage distribution (Card and Krueger, 1995; Brown, 1999). Firms respond to these higher labour costs by reducing employment, reducing profits, or raising prices. While there were over three hundred studies on the employment effects of the minimum wage by 1995 (Card and Krueger, 1995), there were none on its profit effects, and only three on its price effects (Wessels, 1980; Katz and Krueger, 1992; Spriggs and Klein, 1994), plus US Labour Department reports (FLSA 1965 and 1969; MWSC, 1981).

Standard economic theory predicts that minimum wage increases do not reduce profits because low wage firms are usually too small and too competitive to absorb the extra costs. It is then not surprising that empirical evidence is scanty on profit effects. In such competitive markets, prices are assumed to be given, and theory predicts that firms reduce employment in response to minimum wage increases. Indeed this explains why there is such an extensive empirical literature on employment effects. However, theory also predicts that an industry wide cost shock, such as minimum wage increases, will be passed on to prices. The assumption of constant prices is reasonable if firms that are affected compete with firms that are not affected by the increase, but unreasonable if the shock is industry wide. Nonetheless, there is little empirical evidence on price effects – even though this effect was first noted half a century ago (Stigler, 1946).

A comprehensive survey on the price effects of the minimum wage is not available in the literature. Brown's (1999) recent minimum wage survey only includes three such studies: Wessels (1980), Katz and Krueger (1992), and Card and Krueger (1995). Our survey represents an important contribution to the literature because it summarizes and critically compares almost thirty price effect studies. Given the policy relevance of this neglected issue, such a survey is long overdue.

Our survey also contributes to the recent debate over the direction of the employment effect of the minimum wage. The available empirical evidence does not always confirm the negative employment effect that is predicted by theory (Card and Krueger, 1995; Brown, 1999), although small effects, clustered around zero, are becoming prevalent in the literature (Freeman, 1994 and 1996; Brown, 1999). With employment and profits not significantly affected, higher prices are an obvious alternative response to a minimum wage increase. If firms are able to pass the higher costs associated to a minimum wage shock through to prices, employment need not be cut. Thus, evaluating the available evidence on price effects might offer a route to reconciliation between the theoretical predictions and the empirical evidence on employment effects of the minimum wage. The remainder of this paper is organized as follows. In Section 2 we present the underlying theoretical models to the empirical price equation studies reviewed in Section 3. Section 4 summarizes the evidence and concludes.

2 Theoretical Background

In this section, we first discuss the various channels through which, according to theory, the minimum wage affects prices. Next, we divide the available studies in the literature into two categories: estimation of the effect of the minimum wage on economy wide price inflation and estimation of the effect of the minimum wage on prices in various industries. Next we discuss the theoretical approaches utilized in these two broad categories of studies, namely, general equilibrium model, Phillips curve relation and partial equilibrium model (which we then discuss in more detail in Sections 2.1 to 2.3). Finally, we discuss the difficulties in comparing estimates across such studies.

Unlike when estimating the minimum wage effect on employment – where employment equations are usually interpreted as labour demand equations or labour market reduced form equations – the minimum wage effect on prices occurs not only via labour demand and labour supply but also via aggregate demand and aggregate supply. According to economic theory, the minimum wage affects prices through various channels: (1) via labour demand, by pushing costs and prices upwards; (2) via labour supply, by increasing labour productivity, pushing prices downwards; or by increasing labour force participation, pushing wages (prices) downwards; (3) via aggregate supply, by decreasing employment and output, pushing wages and prices upwards; and (4) via aggregate demand, by increasing spending, pushing prices upwards; or by stopping those who became unemployed to spend, pushing prices downwards; or by decreasing the demand for (now more expensive) minimum wage labour intensive goods, pushing prices downwards.[1]

The several steps through which the minimum wage affects prices (the transmission mechanism) can be described as follows. First, there is a direct effect on those between the old and the new minimum wage. Second, there are indirect spillover effects on those above (and below) the new minimum wage. Third, firms raise prices in response to these higher labour cost. Fourth, firms adjust the associated level and mix of input and output (consistent with cost minimisation subject to expected demand). Fifth, the resulting new employment and wage levels combine to produce a new equilibrium income level, aggregate demand and, after some lag, production. Sixth, the inflation and unemployment rates consistent with the new equilibrium might in time again affect wages and prices (Sellekaerts, 1981).

The available studies in the literature can be broadly divided into two categories, depending on the extent to which they account for the several steps of the transmission mechanism: estimation of the effect of the minimum wage on economy wide price inflation and estimation of the effect of the minimum wage on prices in various industries. Earlier studies of the minimum wage effect on prices or inflation often used general equilibrium models, where the effect of the minimum wage on a number of variables is estimated. These models typically account for all steps of the transmission mechanism. A Phillips curve relation, as a function of the minimum wage, was often inserted into such general equilibrium models. Phillips curve relations were also just as often used on their own to estimate the effect of the minimum wage on price inflation. In that case, aggregate demand shifts in response to minimum wage increases are ignored, and the last steps of the transmission mechanism are not accounted for. More recent studies use partial equilibrium models to estimate the effect of the minimum wage on prices for a particular industry, ignoring aggregate demand and aggregate supply shifts (only the first few steps of the transmission mechanism are accounted for). In any given particular industry, assuming perfect competition in the input and output market, an increase in the minimum wage shifts marginal costs upward for all firms, and thus shifts the (product) supply curve

[1] Note that there are also potential capital-labour substitution effects on productivity and output. Also note that in a monopsonistic world the aggregate supply effect works in the opposite direction, i.e. employment and output increase and prices decrease. The decrease in unemployment, in turn, drives prices to increase, and so the aggregate demand effect also works in the opposite direction.

for the industry up. If imperfect competition in the output market is assumed, price is modelled as a markup over costs.

The different methodological approaches reflect the different research questions of interest in the literature, which hinge on the availability of data: aggregate price time series data in the earlier literature and prices by industry and firms in the more recent literature. Indeed, the availability and quality of the data has largely dictated the direction of empirical research.

The main difficulty in comparing estimates across studies using such a variety of methodological approaches and level of data aggregation is the missing link between the empirical specifications and theory. Most studies utilize regression analysis, however, they very rarely discuss the theoretical model that delivered their empirical equation specification. Given the limited discussion on theoretical models to estimate price effects in the literature, a comprehensive survey is not possible. Our strategy is then to present the simplest useful general equilibrium model, Phillips curve relation and partial equilibrium model (Sections 2.1 to 2.3), in an attempt to lay down the rudiments of a link between theoretical and empirical equations.

This missing link is a generalized problem in the minimum wage literature, where empirical models are only loosely related to theory (Brown, 1999). It is a particularly worrying issue in price models because of the various channels through which the minimum wage affects prices. Unless the empirical equation is clearly grounded in theory, it is difficult to pinpoint which step of the transmission mechanism is being estimated. The failure in assessing to what extent the minimum wage coefficient accounts for the transmission mechanism makes it difficult to compare estimates across studies. This is because it is not always clear whether an empirical equation represents a partial or a general equilibrium model, and whether its parameters are structural or reduced form parameters. A single equation can describe two very different processes, as discussed in Sections 2.1 to 2.3. If it describes the partial equilibrium adjustment process in a particular industry, it does not account for all steps of the transmission mechanism. If it describes the economy wide inflation process, accounting for supply and demand effects, it accounts for all steps. We will discuss below that the crucial difference between such two equations is the particular choice of controls and the level of data aggregation used. The choice of controls is given by theory. Consequently, the theoretical model that delivered the empirical equation determines the interpretation of the minimum wage coefficient.

A related issue is the estimation of short and long run price effects. Although theory offers clear predictions, the associated discussion in the specification of empirical equations is again missing in most available studies (see Section 3.5). A final issue, from which few empirical models are exempt, is whether unobservable variables, potentially correlated with the minimum wage, have been controlled for. The available studies rarely discuss endogeneity issues (see Section 3.5).

In sum, most price studies available in the literature utilize regression analysis, and the main issue in regression analysis is identification. To ensure identification: (a) the empirical model needs to be anchored on a particular theoretical model; (b) observable and unobservable variables that have a direct effect on prices need to be controlled for; (c) the empirical model needs to be flexible enough to capture the short and long run effect of the minimum wage on prices; and (d) the empirical counterpart of the theoretical variables needs to be constructed as accurately as possible, which hinges on the quality of the data. Careful consideration of whether these issues have been dealt with in each study is crucial when comparing estimates across studies.

2.1 General Equilibrium Model

2.1.1 System of Equations

General equilibrium models are composed of a set of complex structural equations and accounting identities. Examples of general equilibrium models used to estimate the effect of the minimum wage on a number of variables, including prices, can be found in Sellekaerts (1981) and Cox and Oaxaca (1981) and are discussed in more detail in Section 3.1. The simplest useful general equilibrium model, assuming no role for dynamics or expectations, can be summarized in six equations: skilled and unskilled labour demand and labour supply, aggregate supply and aggregate demand.

Firstly, we borrow a standard labour demand specification from Card and Krueger (1995, p. 184), which can also be found in Hamermesh (1993; p. 23) or Borjas (1996, p. 122). Under the static theory of factor demand, the employment demand function depends on the price of inputs and output. Assuming a production function depending on skilled and unskilled labour and capital, where wages W, the minimum wage W^M and the interest rate r are respectively the input prices, and P is the output price, we can write the associated skilled and unskilled labour demand functions as $L_s{}^d = L_s{}^d(W, W^M, r, P)$ and $L_u{}^d = L_u{}^d(W, W^M, r, P)$.[2]

Secondly, we borrow a standard labour supply specification from Hamermesh (1993, p. 179), which can also be found in Borjas (1996, p. 36). Under the standard theory of labour-leisure choice, we can write the labour supply function as $L^s = L^s(P, W)$. If we assume two types of labour, as above, we obtain two labour supply functions, $L^s{}_s = L^s{}_s\ (P, W)$ and $L^s{}_u = L^s{}_u(P,\ W^M)$, where $L^s{}_s + L^s{}_u = L^s = 1$.

Thirdly, a standard aggregate supply formulation can be found in Romer (1996, p. 228) or Stevenson et al. (1988, p. 26), where aggregate supply Y^s is a function of prices and supply shocks Z: $Y^s = Y^s(P, Z)$. Here, the minimum wage can be included among the supply shocks, as we discuss in more detail in Section 2.2.

Finally, a standard aggregate demand formulation can be found in Romer (1996, p.202) or Stevenson et al. (1988, p. 13), where aggregate demand Y^d is a function of prices and aggregate demand shocks X: $Y^d = Y^d(P, X)$.

Approximating each of these theoretical equations by a logarithmic function, the following system of empirical counterpart equations is typically simultaneously estimated using time series aggregate data:

$$\ln L_{st}^d = \alpha_1 + \beta_1 \ln W_t^M + \gamma_1 \ln W_t + \delta_1 r_t + \rho_1 \ln P_t + v_{1t} \qquad (1)$$

[2] This is the theoretical ground for the typical minimum wage employment equation found in the literature, where capital is assumed fixed in the short run and all prices are normalized by W. There is not much agreement as to whether supply side variables should be included as controls and, if so, which ones. The debate is about whether a reduced form or a demand equation is estimated, depending on whether the minimum wage is binding or not (Neumark and Wascher, 1992; Brown, 1999). For those who earn a minimum wage, employment is demand determined, but for those who earn more, relative supply and demand matter. Typically, employment equations in the literature have been interpreted as demand equations, even though many include supply side variables (Card and Krueger, 1995).

$$\ln L^d_{ut} = \alpha_2 + \beta_2 \ln W^M_t + \gamma_2 \ln W_t + \delta_2 r_t + \rho_2 \ln P_t + v_{2t} \tag{2}$$

$$\ln L^s_{st} = \alpha_3 + \gamma_3 \ln W_t + \rho_3 \ln P_t + v_{3t} \tag{3}$$

$$\ln L^s_{ut} = \alpha_4 + \beta_4 \ln W^M_t + \rho_4 \ln P_t + v_{4t} \tag{4}$$

$$\ln Y^s_t = \alpha_5 + \rho_5 \ln P_t + \lambda_5 \ln Z_t + v_{5t} \tag{5}$$

$$\ln Y^d_t = \alpha_6 + \rho_6 \ln P_t + \chi_6 \ln X_t + v_{6t} \tag{6}$$

where v is the error term.

Assuming that all markets are in equilibrium, i.e., using the accounting identities ${L^d}_u = {L^s}_u$, ${L^d}_s = {L^s}_s$, and $Y^d = Y^s$, it is possible to define empirical counterparts of the theoretical variables. Time series aggregate (national) level data on prices, wages, minimum wages, and interest rate is often directly observed. Labour is defined in the literature as hours worked, number of workers, or the employment rate. Output is usually defined as total production. Aggregate supply shocks might include oil price, productivity growth, social security taxes, union membership, etc. Aggregate demand shocks might include taxes, government spending, etc.[3] We further discuss issues related to dynamics and first differencing in Sections 2.2 and 2.3.

All above equations can be inverted to have price as the dependent variable. Equations 1, 2 and 4 can then be used to estimate the effect of the minimum wage on prices. Each would yield a different β estimate, depending on the other controls. The choice of controls is given by theory. Consequently,

[3] One of the Xs has to be a nominal variable (e.g. nominal Government expenditure or the money stock) to ensure that Y^d (P) is homogeneous of degree zero (one) in nominal magnitudes.

the theoretical model that delivered the empirical equation determines the interpretation of the minimum wage coefficient. For example, while β_4 is the minimum wage price effect when the supply of unskilled workers is held constant; β_2 is the minimum wage price effect when holding constant the demand for unskilled labour, i.e. assuming an inelastic labour demand for unskilled workers. The first tells what happens to prices when the minimum wage changes, accounting for the response of workers; whereas the second tells what happens to prices when the minimum wage changes, accounting for the response of firms (see Section 3.5).[4]

2.1.2 Reduced Form Equation

Another way to estimate the above system of equations is by substituting out the endogeneous variables. For example, the equilibrium conditions ${L^d}_u = {L^s}_u$ and ${L^d}_s = {L^s}_s$ and the definition ${L^s}_s + {L^s}_u = L^s = 1$ can be used to eliminate W.[5] Then, the production function defined above, depending on skilled and unskilled labour and capital, can be used to substitute out L^u and L^s and obtain the aggregate supply equation $Y^S = Y^S(W^M, r, P, K)$, which is an extended version of $Y^s = Y^s(P, Z)$ above. Finally, the equilibrium condition $Y^d = Y^S = Y$ can be used to substitute out Y and obtain the aggregate equilibrium price equation $P = P(W^M, r, K, X)$. Approximating this last theoretical equation by a logarithmic function, the following empirical counterpart equation is obtained, which is typically estimated using time series aggregate data:

$$\ln P_t = \alpha_7 + \beta_7 \ln W_t^M + \delta_7 r_t + \kappa_7 \ln K_t + \chi_7 \ln X_t + v_{7t} \tag{7}$$

Equation 7 is, in econometrics parlance, a reduced form. This equation tells what happens to prices when the minimum wage changes, accounting for responses of firms, workers and consumers. In other words, it accounts for the interaction of all the above variables and their joint effect on

[4]Strictly speaking, inverting Equations 1, 2 and 4 (and 7 and 8 below) to have price as the dependent variable implies that the effect of the minimum wage on prices (β) is deflated by the appropriate coefficient of the price term in each equation (ρ).

[5]Here we use two conditions for market clearing, one for skilled and one for unskilled labour, to show an explicit distinction between the two markets. (We aim at an explicit distinction along the lines of the Welch-Gramlich-Mincer Two Sector Model (Welch, 1976; Gramlich, 1976; Mincer, 1976), though in that model the distinction is between a covered and an uncovered market, rather than between a skilled and an unskilled market). Different assumptions on the labour demand and labour supply for the skilled and unskilled lead to different market equilibrium conditions but the reduced form equation can still be written as a general case of Equation (7).

prices (see Section 3.1).

2.2 Phillips Curve

The last step in the derivation of Equation 7 can, however, be omitted. That is because a Phillips curve relationship can be estimated on its own, rather than inserted into a general equilibrium model. Examples of Phillips curve relations used to estimate the effect of the minimum wage on price inflation can be found in Sellekaerts (1981) and Frye and Gordon (1981) and are discussed in more detail in Section 3.2. By inverting $Y^S = Y^S(W^M, r, P, K)$ and subtracting lagged values, a Phillips curve is obtained. Its empirical counterpart is:

$$\Delta \ln P_t = \alpha_8 + \beta_8 \Delta \ln W_t^M + \delta_8 \Delta r_t + \kappa_8 \Delta \ln K_t + \psi_8 \Delta \ln Y_t + v_{8t} \quad (8)$$

This equation summarizes the possible combinations of price and output that equilibrates the labour market. It tells what happens to prices when the minimum wage changes, accounting for the response of firms and workers, holding output constant. This equation can be informative if it represents an inelastic aggregate supply (for example, because the associated labour demand is inelastic; or because employment is assumed constant given short run changes). However, most people will adjust their spending in response to higher prices. This determines whether and where jobs are lost and employment and output are cut in the longer run. As a result, this equation is not informative if aggregate demand effects play an important role in the effect of the minimum wage on prices. That is the fundamental difference between Equations 7 and 8. While the first accounts for both aggregate supply and aggregate demand effects, the second accounts solely for aggregate supply effects (see Sections 3.1 to 3.3).

However, some aggregate supply and Phillips curve empirical equations available in the literature include aggregate demand variables (see Section 3.2). That is because some authors argue that econometrics explanation of price inflation requires aggregate demand variables, supply shocks (e.g. oil price, exchange rate, productivity growth, etc.) and Government intervention or push-factors (e.g. minimum wage, social security taxes, employment protection, unions, etc.). Also, most specifications include dynamics to account for inertia. They often assume that the static specification is valid at each period, and allow one or two forms of dynamics. One form of dynamics is to include lags and leads of the shock variable to allow the effect of the minimum wage on prices to be complete. Another form of dynamics is to include lags of the dependent variable to account for any lagged adjustment in prices arising from the inability to instantaneously adjust other inputs to minimum wage increases. The number of lags and leads is an empirical matter. All above specifications can be estimated using a short run production function, where capital is fixed. Specifications available in the literature that assume that labour is the only variable factor in the long run constrain the coefficients of capital and interest rate (δ and κ) to zero.

2.3 Partial Equilibrium

While empirical work on the price response to minimum wage increases at the industry level is limited, there is a large empirical literature on the price response to changes in other industry wide costs, such as sales taxes and exchange rates (Poterba, 1996; Goldberg and Knetter, 1997). This so-called pass-through literature is primarily concerned with the burden of higher costs on consumers, and thus is well suited to study the extent to which higher labour costs associated to minimum wage increases are passed on to consumers. The primary objective is to measure whether 100% of the shock is passed through or not. This is estimated by a reduced form equation where price is explained by a cost shock and other controls.[6] Examples of such reduced form equations used to estimate the effect of the minimum wage on price can be found in Card and Krueger (1995) and Machin et al. (2003) and are discussed in more detail in Section 3.4 and 3.5.

In any given particular industry, assuming perfect competition in the input and output market, standard theory predicts that firms set the price equal marginal costs C^M: $P{=}C^M$. An increase in the minimum wage shifts marginal costs upward for all firms, and thus shifts the (product) supply

[6] See Kotlikoff and Summers (1987) for a compendium on tax incidence and Poterba (1996) for a survey. Some authors found full pass-through (Poterba, 1996) and others, overshifting (Besley and Rosen, 1994) in contrast with partial pass-through in the earlier literature (Haig and Shoup, 1934). The literature on the impact of exchange rate movements on import and export prices (Goldberg and Knetter, 1997) usually finds partial pass-through (Gron and Swenson, 1996; Lee, 1997; Yang, 1997). As in the minimum wage price effects literature, the sale taxes and exchange rate literature also used before-and-after, input-output and regression analysis.

curve for the entire industry up. To estimate the price response to an industry cost shock, such as the minimum wage, firm level data is typically utilized in the literature. Approximating this theoretical equation by a logarithmic function and modelling time fixed effects f_t and firm fixed effects f_i using dummies, the following empirical equation is typically estimated using a firm panel data:

$$\Delta \ln P_{it} = \alpha_9 + \varsigma_9 \Delta \ln C_{it}^M + f_{9i} + f_{9t} + v_{9it} \tag{9}$$

If imperfect competition in the output market is assumed, price is modelled as a markup over costs. Card and Krueger (1995, p. 359) present a simple model, which can also be found in Fallon and Verry (1988, p. 123) and we use here.[7] First, assume a number of identically imperfectly competitive firms, each one of them with some market power; because, for example, firms and consumers differ in their physical location and each firm has its own market area. Then, specify a demand and a cost relation and invert the resulting profit maximizing condition to obtain the price equation $P = \left(\frac{e}{1+e}\right) C$, where C is costs and e is the price elasticity of demand. The empirical counterpart of this theoretical equation is:

$$\Delta \ln P_{it} = \alpha_{10} + \varsigma_{10} \Delta \ln C_{it} + f_{10i} + f_{10t} + v_{10it} \tag{10}$$

The main difference between Equations 9 and 10 is the variable cost. In practice, the empirical counterpart of C^M or C is defined much in the same way. The two main components of costs are labour productivity and wages (and the minimum wage affects both). Firm level data on wages is often directly observed. Firm level data on labour productivity A is commonly defined as output divided by number of employees. A measure of the cost of other raw inputs E (e.g. power consumption costs) and a measure of cost of capital (e.g. interest rate) might be included. The expanded version of Equation 9 or Equation 10 is therefore:

[7] Also see Manning (2003) and Bhaskar et al. (2002) for important recent contributions in bringing monopsonistic theory to the analysis of minimum wage effects.

$$\Delta \ln P_{it} = \alpha_{11} + \beta_{11} \Delta \ln W_{it}^{M} + \gamma_{11} \Delta \ln W_{it} + \delta_{11} \Delta r_{it} + \epsilon_{11} \Delta \ln E_{it} + \mu_{11} \Delta \ln A_{it} + f_{11i} + f_{11t} + v_{11it} \quad (11)$$

Indeed, relaxing the price taking assumption does not dramatically change the above specification – the cost function is the same for both monopolists and competitive firms – although it gives a different flavour to the interpretation of the estimates. Setting price as a markup over costs, assuming imperfect competition in the output market, is a special case of setting price at the marginal costs under perfect competition in the output market. The crucial difference here is that while for competitive markets, price is exogenous and the price equation is a standard labour demand function (like Equations 1 or 2 above), for price-setter firms, the price equation reveals a relationship that must hold for profit maximization but it is not a labour demand function, because prices are chosen jointly with employment. Card and Krueger (1995) argue that assuming perfect or imperfect competition in the output market makes little difference for the purposes of estimating the effect of an industry wide shock such as minimum wage increases on employment (and prices).

Equations 1 to 11 above (except Equations 3, 5 and 6) can be used to estimate the effect of the minimum wage on prices. This illustrates the complexity of linkages of the theoretical models, and the many empirical equations that can be delivered as a result. In other words, different theories deliver different empirical equations and different testable relationships between prices and covariates. Testing the efficacy of one model over the other is hard because the models are not always nested. Comparing results across equations is also hard because the various β's in such equations are not directly comparable and might have very different interpretations. The crucial difference between these equations is the particular choice of controls. The choice of controls is given by theory. Consequently, the theoretical model that delivered the empirical equation determines the interpretation of the minimum wage coefficient (see Sections 3.4 and 3.5).

3 Empirical Evidence

In this section we summarize and critically compare the available minimum wage price effect studies. Comparing estimates across such studies is not straightforward because of the variety of methodological approaches and level of data aggregation used. We organize these studies according to the empirical approaches they utilize into five categories: general equilibrium models, Phillips curve relations, input-output models, difference-in-difference models and partial equilibrium models (which we then discuss in more detail in Sections 3.1 to 3.5). We relate these five empirical approaches to the three theoretical approaches discussed in Section 2. The first two estimate the economy wide effect, whereas the last two estimate the sectoral effect of the minimum wage. The third empirical approach can be used to estimate either economy wide or sectoral effects.

3.1 General Equilibrium Model

As discussed in Section 2, earlier studies of the minimum wage effect on prices and inflation often use general equilibrium model (see Equations 1 to 6). Sellekaerts (1981) reviewed four such studies. The effect on wage and price inflation of a 10% increase in the minimum wage across studies ranged from 0.15% to 0.76%. She then criticized these studies on the grounds of several methodological problems, in particular because they did not account for all steps of the transmission mechanism (see Section 2). She attempted to overcome such problems by inserting a modified wage determination equation into the "MIT/PENN/SSRC Macro Model" of the US economy, which she estimated using 1974 to 1979 US time series data. One of the main contributions of this study is that the new wage equation accounts for wage increases that would have taken place regardless of changes in the minimum wage. That is because unless minimum wage increases cause substantial gains in real terms, their effect might not be more than a change in the timing of wage increases that would have occurred anyway. She reported evidence supporting spillover effects; the average annual total impact of a 10% minimum wage increase is 0.6% for wage and 0.2% for price inflation. Sellekaerts' (1981) is one of eight studies published on a special volume on inflation by the US Minimum Wage Survey Commission (MWSC, 1981). The implicit message across these studies is that the effect of the minimum wage on inflation is too small to be a concern. Two of these studies are worth noting, Cox and Oaxaca (1981) and Wolf and Nadiri (1981).

Cox and Oaxaca (1981) used US data from 1974 to 1978 aggregated at industry and macro levels to simulate the effect of freezing the minimum wage at its 1974 level on employment, output, wages and prices using a general equilibrium model of the US. They were primarily concerned with the allocative effects of the minimum wage, which they argue, can only be accurately assessed by a general (not by a partial) equilibrium model. Their results indicate that the minimum wage is not neutral with respect to production, employment, prices and wages. They reported that a 10% increase in the real minimum wage increases the aggregate real wage bill by 0.1%-0.5% (they do not report the effect on prices, but hint that it is larger than that reported in the then existing literature). One of the main contributions of this study was to account for the crucial role of monetary policy accommodating the minimum wage increase. An accommodating inflationary monetary policy was found to offset the disemployment effect of the minimum wage and to increase prices. Corcoran (1981) criticizes the strong assumptions that typically underlie general equilibrium models and points out to measurement error in the data used by Oaxaca and Cox (1981).

More recently, Wilson (1998) reported estimates developed by The Heritage Foundation using the "11 US Macro Model" of the US economy. The proposed 19.4% 1999-2000 increase in the minimum wage was estimated to increase overall prices by 0.2% in the first year and by an additional 0.1% in the second year.

In addition to the criticism of the strong assumptions underlying general equilibrium models, a further criticism is the implicit assumption of a uniformly proportional inflation effect throughout the economy. Minimum wage economy wide effects are hard to find. Table 1 shows that this is around 0.2% across studies. The minimum wage might cause more inflation in sectors or industries overpopulated by minimum wage workers. Input-output models and partial equilibrium models, discussed below, estimate sectoral price effects of the minimum wage.

3.2 Phillips Curve Relation

A Phillips curve relation, as a function of the minimum wage, is not always inserted into general equilibrium models, and it is often estimated on its own, as discussed in Section 2.2 (see Equation 8). Sellekaerts (1981) reviewed seven such studies on wage and price inflation, among which Gramlich (1976) and Falconer (1978). The effect on wage and price inflation of a 10% increase in the minimum wage across these studies ranged from 0.2% to 1.8%; if 1.8% is dropped, the upper end of the range is 0.37%.

Not included in Sellekaerts' (1981) survey is a series of four articles, Gordon (1980) Frye and Gordon (1981), Gordon (1981) and Gordon (1982), which are related to both earlier (Gordon, 1975) and later (Gordon, 1988) studies, where various versions of the Phillips curve are estimated using US annual time series data from 1890 to 1980. The most relevant of these articles to this survey is Frye and Gordon (1981), which focus on the impact of episodes of Government intervention (e.g. minimum wage increases) on inflation, controlling for aggregate demand shifters. A 10% increase in the minimum wage was found to increase inflation by 0.02 percentage points.

The main contribution of the Phillips curve empirical literature is to establish that the econometric explanation of inflation requires supply shocks (e.g. oil price, exchange rate, productivity growth, etc.) and Government intervention or push-factors (e.g. minimum wage, social security taxes, employment protection, unions, etc.) in addition to inertia and aggregate demand variables. This is because push-factors play an important role in the price and wage setting process, affecting real wages and the natural level of unemployment that makes inflation constant (Frye and Gordon, 1978; Gordon, 1982; Layard and Nickell, 1985 and 1986; Jackman et al., 1996; Staiger et al., 1996).[8] To the extent that the way endogeneity problems were dealt with is credible (see Section 3.5), the above models describe the inflation process in the economy through a reduced form equation such as Equation 8 above (controlling for demand shifts), or Equation 7, and the minimum wage estimates should be comparable to the general equilibrium model estimates reported above. Table 1 shows

[8] See Ball et al. (1988) and Goodfriend and King (1990) for surveys on price and inflation modelling. Also see Gali et al. (2001) on the so-called New Phillips curve, which however, does not include the minimum wage.

that estimates from Phillips curve are larger than estimates from general equilibrium models.

3.3 Input-Output Model

Input-output models simulate the changes in policy parameters (e.g. the minimum wage) on employment, output, and prices in the aggregate economy and in industry sector by tracing the inter-industry flow of goods and services. Their estimates can be compared with estimates from an equation such as Equation (7) above.

Wolf and Nadiri (1981) used an input-output model and data from the US CPS (Current Population Survey) to estimate the direct and indirect price effects of the 1963, 1972, and 1979 minimum wage increases. Assuming full pass-through effect, no substitution effects, no employment effect and no spillover effects, they estimate that a 10%-25% minimum wage increase raises prices by 0.3%-0.4%. An important contribution of their model is to account for the failure of input-output models to predict longer run responses. This is because of the implicit assumptions of no substitution among goods and services (as relative prices change) and the associated assumption of employment and output fixed in the short run. Wolf and Nadiri (1981) introduced price and (labour-capital) substitution elasticities in their model, which can then be regarded as a medium run model (Adams, 1981). Another important contribution of this study is the broad approach to the benefits and costs of a minimum wage increase. On the costs side, there are the higher consumer prices; on the benefits side, there are higher productivity and higher output growth resulting from income re-distribution towards low wage groups who have an above average propensity to spend. Sheldon (1981) criticizes this approach because of the typically strong underlying assumptions in input-output models.

More recently, Lee and O'Roark (1999) and Lee et al. (2000) used US earnings and industry data from 1992 and 1997 and a similar input-output model to compute the minimum wage price effect. Once more assuming full pass-through effect, no substitution effect, no employment effect and no spillover effects, they estimate that a 10% minimum wage increase raises prices among eating and drinking places – industries overpopulated by minimum wage workers – by 0.74%. Thus, an important contribution of their work is to produce sectoral estimates. Another important contribution is that they partially relaxed the no spillover effects assumption. Relaxing this assumption is important because further to allowing for the indirect effect of the minimum wage on other wages, it also allows for the wage price interaction in the real wage bargaining process that follows a minimum wage increase. The inflationary effects of the minimum wage might be understated if these effects are ignored. They re-estimated their model allowing for different degrees of spillover effects and found that the larger the extent of spillover effects, the larger the price effects, up to 1.5%.

In a similar fashion to Wolf and Nadiri (1981), MaCurdy and O'Brien-Strain (1997, 2000a and 2000b), O'Brien-Strain (1999) and O'Brien-Strain and MaCurdy (2000) also have a benefits and costs approach to minimum wage increases. They use a similar input-output model and data from the SIPP (Survey of Income and Program Participation) and CES (Consumer Expenditure Survey) to show that the 1999-2000 US minimum wage increase would drive California's families to pay more for goods and services than they would receive through higher earnings. To calculate the benefits, they identify which families have workers earning below the new minimum wage, assume they will have their wages increased to the new minimum wage, and then calculate the new family's earnings. To calculate the costs, they first determine the costs of the minimum wage increase by estimating the expected increase in labour costs and then they trace these costs through to consumer prices. These implied price increases are then used to determine what the extra (consumption) cost is for all families. Once again assuming full pass-through effect, no substitution effect, no employment effect and no spillover effects, they estimate that a 10% minimum wage increase raises prices by 0.3% to 2.16%, depending on the commodity. They compare their results to Lee and O'Roark's (1999). Using an extended sample of US states, MaCurdy and McIntyre (2001) applied the same methodology and data from the SIPP and US Census to analyze the 1996-1997 US minimum wage increase. They estimated that a 10% minimum wage increase raises overall prices by 0.25%, and prices of food consumed outside (inside) home by 1.2% (0.8%). They compared their results with Lee and O'Roark's (1999) and Aaronson's (2001)[9] and argue that differences with the latter stem from the difference-in-methodology. They also estimated the effect of the national 1996-1997 minimum

[9] They compare it with an earlier version of Aaronson's paper.

wage increase on four states: California, Florida, New York and Texas but did not find qualitatively different results.

Despite of the insightful way the authors exploit the short run nature of the input-output model, an important drawback of these studies is the model's underlying assumptions. The assumption that employment is fixed, and therefore that output is fixed, can only be maintained because of the assumption of no change in the spending patterns. However, as discussed in Section 2.1, most people will adjust their spending in response to higher prices, affecting employment and output, as acknowledged by the authors. This might overestimate the cost (and price) effects of a minimum wage increase, which would be mitigated by a reduction of employment or profits (although adverse employment effects might also mitigate the benefits of a minimum wage increase). Furthermore, the benefit effects of the minimum wage might be underestimated because of the no spillovers assumption, whereby only families with workers earning below the minimum wage benefit from the increase. These underlying assumptions produce a highly stylized and unrealistic model and cast doubts on the results.

Three other usual assumptions in input-output models are full pass-through, full coverage and full compliance, which might overstate the price effects of the minimum wage. Because of these, the estimates produced by input-output models are usually regarded as upper bound effects of the increase. An advantage of input-output models is that they account for the minimum wage effect propagated throughout the economy via its effects on intermediate goods. Even if an industry employs no minimum wage workers, its prices might rise because of its use of goods or contracts for services produced with minimum wage labour.

To the extent that the way the assumptions underlying input-output models were dealt with is credible, the minimum wage estimates should be comparable to the general equilibrium model and Phillips curve relation estimates reported above (i.e., the estimates would be comparable with estimates from an equation such as Equation 7 above). It appears, however, that inspite of important improvements, the final estimates still did not account for all the steps in the transmission mechanism (see Section 2) (i.e., the estimates are comparable with estimates from an equation such as Equation

8 or Equation 11 above). Nonetheless, it is noteworthy that their directions and magnitudes are in line with those above, as shown in Table 1.

3.4 Difference-in-Difference Model

A technique to estimate the minimum wage effect on other variables (e.g. prices, employment, etc.) that has been extensively used in the minimum wage literature is difference-in-difference estimation (Brown, 1999). The idea is to compare high and low wage regions, on the assumption that the minimum wage has a larger effect on prices in lower wage regions. This makes it possible to remove the effect of factors that affect the prices of all regions, such as common macro shocks. If the remaining factors are randomly distributed across regions, the change in relative prices is a measure of the minimum wage effect on prices.

This technique is equivalent to regression analysis. For instance, take Equation 11 above and constrain all but the coefficient β_{11} to zero. The estimates of this constrained equation, utilizing data for two time periods and two regions only, are the same as difference-in-difference estimates. Naturally, the method can be extended to more time periods and regions and to controlling for other supply and demand shocks (respectively, the unconditional and the conditional method). The choice of controls would determine the interpretation of the estimates, as discussed in Section 2.

The Department of Labor studies published several studies on the effects of the 1961 and 1967 US minimum wage increases (FLSA, 1965 and 1969) using difference-in-difference estimators to compare US Southern and non-Southern industry prices, assuming a larger minimum wage effect in the first. Wholesale prices of industrial commodities and price trends for low wage industries were relatively stable. Even though the minimum wage increases became effective during a period of rising prices, they were said to have had little influence on this upward trend.

Using the same method and data, Wessels (1980) re-examined the evidence from the Department of Labor Studies. He hypothesized that prices should be identical if Southern and non-Southern industries sold their goods in the same markets and consumers regarded these goods as nearly the same. In this case a minimum wage increase would have no effect on the relative prices of

Southern goods but would decrease Southern employment. He concluded that evidence supporting the competitive assumption is weak and that Southern firms should be able to pass higher relative costs on to consumers' prices. He found little consistent pattern in price increases in manufacturing, but faster price increases in Southern services. A 10% increase in the minimum wage was found to increase prices in the services sector by 2.71% following the 1966-1967 minimum wage increase.

Using difference-in-difference estimation and data on fast-food restaurants – an industry overpopulated by minimum wage workers – Katz and Krueger (1992) and Card and Krueger (1995) compared prices in New Jersey and Pennsylvania following the 1992 New Jersey minimum wage increase. They also used the same data and regression analysis to estimate the minimum wage price effect using reduced form equations. They found a positive but statistically not significant estimate. Within New Jersey, however, they found that prices rose just as quickly at restaurants paying the minimum wage and at restaurants already paying as much as, or more than the new minimum wage. They argued that restaurants within New Jersey compete in the same product market, and therefore those most affected by the minimum wage increase are unable to increase their prices by more, whereas restaurants in Pennsylvania compete in a different product market, enabling prices to rise in New Jersey relative to Pennsylvania. Similar findings in their Texas survey suggest that prices rose at about the same rate in fast-food restaurants that made larger or smaller wage adjustments following the 1990-1991 US federal minimum wage increases (they found a negative but not statistically significant estimate). Card and Krueger (1995) provided further evidence by comparing restaurant average price increases across a broader cross-section of cities and states, following the 1990-1991 US federal minimum wage increases. They used regression analysis and two different sources of price data, CPI and ACCRA (Council for Community and Economic Research). They found evidence that restaurant prices rose faster in states that made larger adjustments following the federal minimum wage increase, and cities with higher proportions of low wage workers in 1989.

Overall, Card and Krueger's (1995, p. 54) findings are imprecise and mixed, but suggest that a 10% minimum wage increase raises prices by up to 4%. This is consistent with predictions from a competitive model. A minimum wage increase raises prices in proportion to the minimum wage workers labour's share in total cost. They find that the ratio between the price and wage effects approximates this share. Their findings are also consistent with the existence of an imperfectly competitive product market.

Spriggs and Klein (1994) conducted a similar experiment to Katz and Krueger (1992), differing only in the timing between the change in the minimum wage and the follow-up survey. They utilize data for one month before and after the 1991 US minimum wage increase, which, they argue, already accounts for long run adjustments because the increase was announced two years in advance. Their findings suggest that the minimum wage did not significantly affect prices, which continued changing following a prior trend.

There has been much debate and criticism in the literature regarding three methodological issues in difference-in-difference estimation. The first is the validity of the control group, which needs to capture the change that would happen to the variable of interest (e.g. prices) in the absence of a minimum wage increase, i.e. changes due to other common macro shocks. The second is the contamination of the treatment group prior to the treatment (for example, because minimum wage changes are announced in advance, firms might start adjusting prices prior to the enactment date). The third is the amount of time elapsed between the minimum wage increase enactment date and the "after" survey (for example, if data is collected too soon after the increase, there might not have been enough time to allow for the impact of the increase on prices). The first two can bias the estimates; the third determines whether the estimates are short or long run. In other words, the reliability of the estimates lies on the non-contamination of the control and treatment groups by the treatment, and by the appropriate timing of the surveys. Card and Krueger (1995) have been extensively criticized on these three issues (Brown, 1999). Hamermesh (1995) is particularly critical of the timing of their surveys, arguing that the "before" survey was after firms had already started to adjust to the minimum wage increase and the "after" survey was before full adjustment had occurred. Card and Krueger's (1995) defence relies on the traditional argument that adjustment occurs with neither leads nor lags because turnover is high in the fast food industry.

Difference-in-difference estimates do not compare to the above general equilibrium model, Phillips curve relation and input-output model estimates because they do not account for all the steps in the transmission mechanism (see Section 2). They describe the partial equilibrium adjustment process to minimum wage increases in a particular industry (for example, fast-food industry). The estimates here reported can be compared to the sectoral (food industry) estimates in Lee and O'Roark (1999) and in MaCurdy and McIntyre (2001), which however, are not restricted to the fast-food industry. Table 1 shows that the latter are larger.

3.5 Partial Equilibrium Model

In addition to the Katz and Krueger (1992) and Card and Krueger (1995) regression models estimates discussed in Section 3.4, Aaronson (2001), MacDonald and Aaronson (2002), and Aaronson et al. (2003) used regression analysis to examine the effect of the 1980s and 1990s minimum wage increases on prices in the US and Canada. This allowed them to exploit variation in time and location to identify their estimates. Aaronson (2001) used data from BLS (Bureau of Labor Statistics) for metro areas between 1978 and 1997, and from ACCRA and StatCan data; Macdonald and Aaronson (2002) used data from the Food Away from Home component of the CPI in a wider sample of metro areas from 1995 to 1997 as well as data from CPS. They estimate that a 10% minimum wage increase raises prices by 0.72%-0.74%. These estimates are remarkably close to Lee and O'Roark's (1999) estimates, which use an entirely different methodology and data.

The authors contributed to the literature by performing a number of robustness checks, for example: (a) They argued that the minimum wage might be endogenously determined with prices if politicians favour minimum wage increases in high inflation periods (when the real minimum wage erodes faster). Though they do not use very robust methods to circumvent problems arising from endogeneity (they simply look at inflation patterns before the enactment date of the legislation), they concluded that endogeneity is not much of a concern. (b) They estimated the minimum wage price effect in low and high inflation periods and found that high inflation partially drives the significant minimum wage pass-through coefficient, which can be as large as 1.6%. (c) They also found evidence that prices respond quickly to minimum wage increases, within a 4 to 6 months window around the increase. This suggests that although the increase is announced many months in advance, there is no price response leading up to the enactment date. It also suggests that the price effect of the minimum wage is a short run phenomenon that dissipates over time. This is in line with the traditional argument discussed above that adjustment occurs with neither leads nor lags. They warn that minimum wage increases might not generate the sort of coordination failure and stickiness in prices that other costs or demand shocks produce. (d) Their evidence also suggests that prices increase more in low wage areas, in line with prior expectations. Similar to Card and Krueger (1995), the authors remarked that the evidence they found is consistent with predictions from a competitive model of full pass-through of costs onto prices.

Machin et al. (2003) use regression analysis to estimate the effects of the introduction of the UK national minimum wage, in April 1999, on the residential care homes industry, a heavily affected sector. They found no evidence that prices rose by more in low wage firms. An important drawback, acknowledged by the authors, is that price regulations limit the extent of price adjustments on this particular market.

Draca et al. (2005) also provide evidence for the UK. They use regression analysis to estimate the effects of the minimum wage on prices at the industry level utilizing 1987 to 1991 consumer price data (RPI) and 1992-2003 producer price data (PPI) across three low-pay industries: restaurants, takeaway and canteens. As in Machin et al. (2003) they were also unable to find evidence of minimum wage price effects. One advantage of this study is that they implement instrumental variable estimation, using the proportion of low paid in each industry as the instrument for the minimum wage, which did not alter the main conclusion of no significant price effects. Their study was cited by the Low Pay Commission Report (LPC, 2005) as evidence of limited price effects of the minimum wage in the UK, though they note the methodological difficulties involved in researching this area acknowledged by the authors.

As discussed in Section 2, the main issue in regression analysis is identification. The main drawback of the above regression models is the missing link between the empirical specifications and theory. These studies are grounded on the standard theoretical prediction that if employers do not respond to changes in the minimum wage by reducing employment or profits, they respond by raising prices. However, none of them explicitly discusses the theoretical model that delivered their empirical equation specification. Unless the empirical equation is clearly grounded in theory, it is difficult to pinpoint which step of the transmission mechanism is being estimated, as discussed in Section 2. The failure in assessing to what extent the pass-through coefficient accounts for the transmission mechanism makes it difficult to compare estimates across studies. For example, the specifications estimated by Card and Krueger (1995), Sprigs and Klein (1994), Machin et al. (2003) and Draca et al. (2005) can be thought of as reduced form equations such as Equation (11). The specification estimated by Aaronson (2001) can be thought of as a labour demand curve such as Equation (1). Nonetheless, although the authors do not specify a model, Card and Krueger (1995), Machin et al. (2003) and Draca et al. (2005) make serious attempts to identify the effect of the minimum wage in sectors overpopulated by minimum wage workers, where there is a better possibility of observing the employment and price effects predicted by theory. Another issue is the estimation of short and long run price effects. Only MacDonald and Aaronson (2002) and Aaronson (2001) estimate the long run effects, which for Canada and the US seem to be small. A further criticism, is whether unobservable variables, possibly correlated to the minimum wage, have been controlled for. Only Aaronson (2001) and Draca et al. (2005) attempted to discuss the potential endogeneity of the minimum wage in price models, which for the US and US does not seem to be strong.

As it was the case for the difference-in-difference estimates, the regression analysis estimates do not compare to the above general equilibrium model, Phillips curve relation and input-output model estimates because they do not account for all the steps in the transmission mechanism. Once again, they describe the partial equilibrium adjustment process to minimum wage increases in a particular industry (for example, fast-food industry, care homes industry, etc.). As before, these estimates can be compared to the sectoral (food industry) estimates in Lee and O'Roark (1999) and MaCurdy and McIntyre (2001). Table 1 shows that the estimates here are in line with the lower estimates in those studies. The estimates here can also be compared to the difference-in-difference estimates above, which however use data for the fast food industry only and are smaller.

3.6 Developing Countries

There are only four studies on the price effects of the minimum wage for two developing countries, Brazil and Costa Rica. For Brazil, where minimum wage increases are large and frequent, and the minimum wage is binding for a sizable fraction of the labour force, such increases have an impact on overall prices (see Section 3.1). For example, Lemos (2006a) uses regression analysis and monthly consumer price data (CPI) as well as household data (Monthly Employment Survey or Pesquisa Mensal do Emprego, PME) and firm data (Monthly Industrial Survey or Pesquisa Industrial Mensal, PIM) data between 1982 and 2000 and finds that a 10% increase in the minimum wage raises overall prices by 0.8% after five months of adjustment (a two months window around the increase).

Lemos (2004) uses the same data and further exploits the information on the prices of goods consumed by the poor and by the rich. She also uses a different definition of the minimum wage variable in her regression models. She finds that a 10% increase in the minimum wage raises prices paid by the poor (rich) by 0.12% (0.04%) in the month of the increase, by 0.27% (0.16%) after six months, and by 0.17% (0.15%) after twelve months. This implies that poor consumers in Brazil experience inflation rates three times higher than rich consumers in the month of the increase. This differential effect diminishes over time with the poor experiencing twice the inflation rate of the rich after six months, but roughly the same rate after a year of adjustment. The author probes these results to alternative specifications but they remain larger than the 0.2% to 0.4% overall price effect found in the US (see Sections 3.1 to 3.3).

Lemos (2006b) found even larger estimates when using the same data but accounting for wage spillover effects of the minimum wage and performing a number of instrumental variable robustness checks. She reports that a 10% increase in the minimum wage raises prices by 1.3% in the month of the increase, by a further 1.1% in the two months leading up to the increase and by a further 1.4% in the two months after the increase. After accounting for anticipated and lagged adjustments in prices during a two months window around the increase, overall prices rise by 3.5%. Nonetheless, she shows that price effects of the minimum wages are substantially smaller in low inflation periods, when they are insignificantly different from zero. The author suggests that the potential of the minimum wage to help the poor is bigger under low inflation. Under high inflation, a resulting wage-price spiral makes the minimum wage increase – as well as its antipoverty policy potential – short lived, as also suggested by Gramlich (1976) and Freeman (1996).

Lemos (2006b) contributed to the literature by making a serious attempt to address a number of the most important, yet neglected, issues discussed above: (a) She specified a theoretical model which she then used to deliver her empirical equation specification. She departed from a partial equilibrum empirical specification similar to Equation (10), though limitations in disaggregating the CPI data meant that she could not estimate it at the firm or industry level, but only at the regional level. This meant that she estimated economy wide price effects whose results are comparable to estimates from general equilibrium models or Phillips curve relation estimates above (see Sections 3.1 and 3.2). (b) She carefully addressed the various definitions of minimum wage variables used in the literature comparing their estimates. She pointed out that this variety of variables may pose a further obstacle when comparing estimates across studies. (c) She accounted for the impact on prices of wage spillover effects on workers above and below the minimum wage associated to minimum wage increases. This produced larger estimates in comparison to her earlier studies. (d) She implemented instrumental variable estimation, using the proportion of minimum wage workers in each region as the instrument for the minimum wage, which again produced larger estimates. (e) She estimated the minimum wage price effect in low and high inflation periods and provided convincing evidence that high inflation drives the results, as also suggested by Aaronson (2001) and Weiss (1993). (f) Finally, she estimated long run price responses and, like Aaronson (2001), also found evidence that prices respond quickly to minimum wage increases, within a few months window around the increase.

For Costa Rica, Gindling and Lemos (2006) use yearly consumer price data (CPI) as well as household data (Household Survey of Employment and Unemployment or Encuestas de Hogares de Propositos Multiples, EHPM) between 1987 and 1994 across industry categories and find little evidence of minimum wage price effects. The authors follow a similar specification to Lemos (2006b). One drawback of this study is that, due to monthly data being unavailable, the authors use yearly data, which might not capture price effects of the minimum wage. Likewise, the authors acknowledge the difficulty to obtain data for a longer time period. Another drawback, as acknowledged by the authors, is that they do not do robustness checks for industries most affected by minimum wage increases, and therefore their economy wide estimates might be diluting a potentially positive price effect in more heavily affected low paid sectors or industries.

Comparisons across studies – even when all studies utilize data for the same country, say the US – are difficult because of different techniques, data period, and data sources. Comparison across studies for developing countries, or across studies for developing and developed countries are even more difficult because the effect of the minimum wage on prices depends on the minimum wage level (and enforcement) and on labor market particularities and institutions in each country. Here, all that seems relatively safe to conclude is that economy wide price effects of minimum wage increases are considerably larger in Brazil than in the US. This results from specificities in the Brazilian economy, such as large and frequent minimum wage increases affecting a sizable fraction of the labour force. Such specificities suggest that the economics of the minimum wage in developing countries might be very different from that of developed countries. However, results for Brazil might not be directly informative about results for other developing countries because of differences in the structure of the labor market and the economy more generally. For example, results for Costa Rica are closer to those for the US than to those for Brazil. Furthermore, even for Brazil, the result of a large overall price effect needs to be qualified as no price effects were found in low inflation periods. More research on the price effects of the minimum wage is needed in the literature, in particular for developing countries, before we can draw any further conclusions. As remarked by Hamermesh (2002), evidence from developing countries really is greatly lacking in the literature.

4 Conclusion

This survey fills a gap in the minimum wage literature by reviewing and comparing almost thirty studies that estimate the effect of the minimum wage on prices. Given the relevance of this neglected issue both to policymaking and to the debate in the literature over the minimum wage employment effect, such a survey is long overdue.

Despite the different methodologies, data periods and data sources, most studies reviewed above found that a 10% US minimum wage increase raises food prices by no more than 4% and overall prices by no more than 0.4%. This is in line with Brown's (1999, p. 2150) remark, in his recent minimum wage survey, that "the limited price data suggest that, if anything, prices rise after a minimum wage increase".

The overall reading of our survey on price effects, together with the evidence in the literature on wages and employment effects, is that the minimum wage increases the wages of the poor, does not destroy too many jobs, and does not raise prices by too much. The main policy recommendation deriving from such findings is that policy makers can use the minimum wage to increase the wages of the poor, without destroying too many jobs or causing too much inflation.

Further to informing the policy debate, our survey also offers an important input to reconcile theoretical predictions of negative employment effect and the mixed empirical evidence of negative and non-negative employment effects in the literature. Empirical evidence of positive wage and price effects and non-negative employment effects is consistent with standard theory. This suggests that firms respond to minimum wage increases not by reducing production and employment, but by raising prices. This is indeed what is observed in practice, as documented by Converse et al. (1981), "The most common types of responses to the increase in the minimum wage were price increases and wage ripples. No single type of disemployment response was reported with nearly the frequency of these".

References

[1] AARONSON, D. (2001): "Price Pass-through and the Minimum Wage," *Review of Economics and Statistics*, 83, 158-169.

[2] AARONSON, D., E. FRENCH, and J. MACDONALD (2003): "Product Market Evidence on the Employment Effects of the Minimum Wage," *mimeo.*

[3] ADAMS, A. (1981): "A Simulation Model of the Effect of an Increase in the Minimum Wage on Employment, Output and the Price Level, Comment," *Report of the Minimum Wage Study Commission*, 6, 233-235.

[4] BALL, L., N. G. MANKIW, and D. ROMER (1988): "The New Keynesian Economics and the Output-Inflation Trade-Off," *Brookings Papers on Economic Activity*, 1988, 1-65.

[5] BESLEY, T. J., and H. S. ROSEN (1999): "Sales Taxes and Prices: An Empirical Analysis," *National Tax Journal*, 52, 157-178.

[6] BHASKAR, V., A. MANNING, and T. TO (2002): "Oligopsony and Monopsonistic Competition in Labor Markets," *Journal of Economic Perspectives*, 16, 155-174.

[7] BORJAS, G. (1996): *Labor Economics.* US: McGraw-Hill.

[8] BROWN, C. (1999): "Minimum Wages, Employment, and the Distribution of Income," in *Handbook of Labor Economics*, ed. by O. Ashenfelter, and D. Card. Amsterdam; New York and Oxford: Elsevier Science, North-Holland, 2101-2163.

[9] CARD, D. E., and A. B. KRUEGER (1995): *Myth and Measurement: The New Economics of the Minimum Wage.* Princeton: Princeton University Press.

[10] COX, J., and R. OAXACA (1981): "Effects of Minimum Wage Policy on Inflation and on Output, Prices, Employment and Real Wage Rates by Industry," *Report of the Minimum Wage Paper Commission*, 6, 171-210.

[11] CONVERSE, M., R. COE, M. CORCORAN, M. KALLICK, and J. MORGAN (1981): "The Minimum Wage: An Employer Survey," *Report of the Minimum Wage Study Commission*, 6, 241-341.

[12] CORCORAN, M. (1981): "Effects of Minimum Wage Policy on Inflation and on Output, Prices, Employment and Real Wage Rates by Industry, Comment," *Report of the Minimum Wage Study Commission*, 6, 211-213.

[13] DRACA, M., S. MACHIN, and J. V. REENEN (2005): "The Impact of the National Minimum Wage on Profits and Prices," *Report for Low Pay Commission.*

[14] FALCONER, R. T. (1978): "The Minimum Wage: A Perspective," *Federal Reserve Bank of New York Quarterly Review*, 3, 3-6.

[15] FALLON, P. and D. VERRY (1988): *Labour Markets.* UK: Philip Allan Publishers.

[16] FLSA, Fair Labor Standard Act (1965): *An Evaluation of the Minimum Wage and Maximum Hours Standards under the Fair Labor Standards Act.* Washington: US Department of Labor.

[17] — (1969): *Minimum Wage and Maximum Hours Standards under the Fair Labor Standards Act.* Washington: US Department of Labor.

[18] FRYE, J., and R. J. GORDON (1981): "Government Intervention in the Inflation Process: The Econometrics of "Self-Inflicted Wounds"," *American Economic Review*, 71, 288-294.

[19] FREEMAN, R. B. (1994): "Minimum Wages–Again!," *International Journal of Manpower*, 15, 8-25.

[20] — (1996): "The Minimum Wage as a Redistributive Tool," *Economic Journal*, 106, 639-649.

[21] GALI, J., M. GERTLER, and J. D. LOPEZ SALIDO (2001): "European Inflation Dynamics," *European Economic Review*, 45, 1237-1270.

[22] GINDLING, T., and S. LEMOS (2006): "The Effects of the Minimum Wage on Prices in Costa Rica," *mimeo.*

[23] GRAMLICH, E. M. (1976): "Impact of Minimum Wages on Other Wages, Employment, and Family Incomes," *Brookings Papers on Economic Activity*, 2, 409-451.

[24] GOLDBERG, P. K., and M. M. KNETTER (1997): "Goods Prices and Exchange Rates: What Have We Learned?," *Journal of Economic Literature*, 35, 1243-1272.

[25] GOODFRIEND, M., and R. G. KING (1997): "The New Neoclassical Synthesis and the Role of Monetary Policy," in *Nber Macroeconomics Annual 1997*, ed. by B. S. Bernanke, and J. J. Rotemberg. Cambridge and London: MIT Press, 231-283.

[26] GORDON, R. J. (1975): "The Impact of Aggregate Demand on Prices," *Brookings Papers on Economic Activity*, 3, 613-662.

[27] — (1980): "A Consistent Characterization of a near-Century of Price Behavior," *American Economic Review*, 70, 243-249.

[28] — (1981): "Price Inertia and Policy Ineffectiveness in the United States, 1890-1980," *National Bureau of Economic Research Working Paper Series*, 744.

[29] — (1982): "Inflation, Flexible Exchange Rates, and the Natural Rate of Unemployment," in *"Workers, Jobs and Inflation"*, ed. by M. N. Baily. US: The Brookings Institution, 89-158.

[30] — (1988): "The Role of Wages in the Inflation Process," *American Economic Review*, 78, 276-283.

[31] GRAMLICH, E. M. (1976): "Impact of Minimum Wages on Other Wages, Employment, and Family Incomes," *Brookings Papers on Economic Activity*, 2, 409-451.

[32] GRON, A., and D. L. SWENSON (1996): "Incomplete Exchange-Rate Pass-through and Imperfect Competition: The Effect of Local Production," *American Economic Review*, 86, 71-76.

[33] HAIG, R., and C. SHOUP (1934): *The Sales Taxes in the American States*. New York: Columbia University Press.

[34] HAMERMESH, D. (1993): *Labor Demand*. US: Princeton University Press.

[35] — (1995): "Myth and Measurement: The New Economics of the Minimum Wage: Review Symposium: Comment," *Industrial and Labor Relations Review*, 48, 835-838.

[36] — (2002): "International Labor Economics," *Journal of Labor Economics*, 20, 709-732.

[37] JACKMAN, R., R. LAYARD, and S. NICKELL (1996): "Structural Aspects of Oecd Unemployment," *mimeo*.

[38] KATZ, L. F., and A. B. KRUEGER (1992): "The Effect of the Minimum Wage on the Fast-Food Industry," *Industrial and Labor Relations Review*, 46, 6-21.

[39] KOTLIKOFF, L., and L. SUMMERS (1987): "The Theory of Tax Incidence," in *Handbook of Public Economics*, ed. by A. Auerbach, and M. Feldstein. Amsterdam: North Holland.

[40] LAYARD, P. R. G., and S. J. NICKELL (1985): "Unemployment, Real Wages, and Aggregate Demand in Europe, Japan and the United States," *Carnegie Rochester Conference Series on Public Policy*, 23, 143-202.

[41] LAYARD, R., and S. J. NICKELL (1986): "Unemployment in Britain," *London School of Economics, Centre for Labour Economics Paper*, 240.

[42] LEE, J. (1997): "The Response of Exchange Rate Pass-through to Market Concentration in a Small Economy: The Evidence from Korea," *Review of Economics and Statistics*, 79, 142-145.

[43] LEE, C., and B. O'ROARK (1999): "The Impact of Minimum Wage Increases on Food and Kindred Products Price: An Analysis of Price Pass-Through," *US Department of Agriculture Technical Bulletin*, 877.

[44] LEE, C., G. SCHLUTER, and B. O'ROARK (2000): "How Much Would Increasing the Minimum Wage Affect Food Prices?," *Current Issues in Economics of Food Markets - Agriculture Information Bulletin*, 747-03.

[45] LEMOS, S. (2004): "Do Minimum Wage Price Effects Hurt the Poor More?" *Revista Economica*, 50, 67-83.

[46] — (2006a): "Minimum Wage Effects on Wages, Employment and Prices: Implications for Poverty Alleviation in Brazil," *University of Leicester Discussion Paper*, 05/15.

[47] — (2006b): "Anticipated Effects of the Minimum Wage on Prices," *Applied Economics*, 38, 325-337.

LPC, L. P. C. (2005): *National Minimum Wage.* London: Her Majesty's Stationary Office.

[48] MACDONALD, J., and D. AARONSON (2002): "How Do Retail Prices React to Minimum Wage Increases?," *mimeo.*

[49] MACURDY, T., and F. MCINTYRE (2001): "Winners and Losers of Federal and State Minimum Wages," *Employment Policies Institute Foundation Paper*, 6/01.

[50] MACURDY, T., and M. O'BRIEN-STRAIN (1997): "Who Will Be Affected by Welfare Reform in California," *mimeo.*

[51] — (2000a): "Who Pays for Increases in the Minimum Wage: Distributional Effects Assuming Price Pass-Through," *mimeo.*

[52] — (2000b): "Who Benefits and Who Pays for Minimum Wage Increases in California? A Perspective on Proposition 210," Essays in Public Policy, 78.

[53] MACHIN, S., A. MANNING, and L. RAHMAN (2003): "Where the Minimum Wage Bites Hard: Introduction of Minimum Wages to a Low Wage Sector," *Journal of The European Economic Association*, Inaugural Issue, 154-180.

[54] MANNING, A. (2003): *Monopsony in Motion.* Princeton: Princeton University Press.

[55] MINCER, J. (1976): "Unemployment Effects of Minimum Wages," *Journal of Political Economy*, 84, S87-S104.

[56] MWSC, MINIMUM WAGE STUDY COMMISSION (1981): *Report of the Minimum Wage Study Commission.* Washington: US Department of Labor.

[57] NEUMARK, D., and W. WASCHER (1992): "Employment Effects of Minimum and Subminimum Wages: Panel Data on State Minimum Wage Laws," *Industrial and Labor Relations Review*, 46, 55-81.

[58] O'BRIEN-STRAIN, M. (1999): "Distributional Effects of the Minimum Wage: Who Benefits and Who Pays for Increases in the Federal Minimum Wage 1996/97 and 1999/2000," Standford University.

[59] O'BRIEN-STRAIN, M., and T. MACURDY (2000): "Increasing the Minimum Wage: California's Winners and Losers," *Public Policy Institute of California Discussion Paper*, 131.

[60] POTERBA, J. M. (1996): "Retail Price Reactions to Changes in State and Local Sales Taxes," *National Tax Journal*, 49, 165-176.

[61] ROMER, D. (1996): *Advanced Macroeconomics.* US: McGraw-Hill.

[62] SELLEKAERTS, B. (1981): "Impact of Minimum Wage Legislation on Wage and Price Inflation," *Report of the Minimum Wage Paper Commission*, 6, 1-17.

[63] SHELDON, R. (1981): "A Simulation Model of the Effect of an Increase in the Minimum Wage on Employment, Output and the Price Level, Comment," *Report of the Minimum Wage Study Commission*, 6, 237-239.

[64] SPRIGGS, W., and B. KLEIN (1994): "Raising the Floor - the Effects of the Minimum Wage on Low-Wage Workers," *mimeo.*

[65] STAIGER, D., J. H. STOCK, and M. W. WATSON (1996): "How Precise Are Estimates of the Natural Rate of Unemployment?," *National Bureau of Economic Research Working Paper Series*, 31.

[66] STEVENSON, A., V. MUSCATELLI and M. GREGORY. (1988): *Macroeconomic Theory and Stabilisation Policy.* UK: Plilip Allan Publishers.

[67] STIGLER, G. (1946): "The Economics of Minimum Wage Legislation," *American Economic Review*, 36, 358-365.

[68] WEISS, Y. (1993): "Inflation and Price Adjustment: A Survey of Findings from Micro-Data," in *Optimal Pricing, Inflation, and the Cost of Price Adjustment*, ed. by E. Sheshinski, and Y. Weiss. Cambridge and London: MIT Press, 3-17.

[69] WELCH, F. R., and J. CUNNINGHAM (1978): "Effects of Minimum Wages on the Level and Age Composition of Youth Employment," *Review of Economics and Statistics*, 60, 140-145.

[70] WESSELS, W. (1980): *Minimum Wages, Fringe Benefits and Working Conditions.* Washington: American Enterprise Institute.

[71] WILSON, M. (1998): "Increasing the Mandated Minimum Wage: Who Pays the Price?," *mimeo.*

[72] WOLF, E., and M. NADIRI (1981): "A Simulation Model of the Effect of an Increase in the Minimum Wage on Employment, Output and the Price Level," *Report of the Minimum Wage Paper Commission*, 6, 217-232.

[73] YANG, J. (1997): "Exchange Rate Pass-through in U.S. Manufacturing Industries," *Review of Economics and Statistics*, 79, 95-104.

Table 1 - Estimated Effect of a 10% Increase in the Minimum Wage on Prices across Studies

Study	Data	Method	Price Effect
Economy Wide Effect			
Sellekaerts (1981)	1974 to 1979 US time series data	general equilibrium model	0.20%
Cox and Oaxaca (1981)	1974 to 1978 US industry and macro level data	general equilibrium model	>0.20%
Wilson (1998)	1999-2000 US macro level data	general equilibrium model	0.02%
Gramlich (1976)	1948 to 1975 US time series data	Phillips curve estimation	<0.28%
Falconer (1978)	1938 to 1978 US time series data[1]	Phillips curve estimation	0.33%
Frye and Gordon (1981)	1890 to 1980 US time series data	Phillips curve estimation	0.02pp
Wolf and Nadiri (1981)	1963, 1972 and 1979 US CPS data	input-output model	0.30% to 0.40%
MaCurdy and O'Brien-Strain (1997, 200a and 200b), O'Brien-Strain (1999) and O'Brien-Strain and MaCurdy (2000)	1999 to 2000 US SIPP and CES California data	input-output model	0.30% to 2.16%
Lemos (2004)	1982 to 2000 Brazil CPI, household (PME) and firm (PIM) level data	regression analysis	0.04% to 0.27%
Lemos (2006a)	1982 to 2000 Brazil CPI, household (PME) and firm (PIM) level data	regression analysis	0.80%
Lemos (2006a)	1982 to 2000 Brazil CPI, household (PME) and firm (PIM) level data	regression analysis	3.50%
Gindlin and Lemos (2006)	1987 to 1994 Costa Rica CPI and household (HSEU) level data	regression analysis	no effect
Sectoral Effect			
Lee and O'Roark (1999) Lee et al. (2000)	1992 and 1997 US eating and drinking earnings and industry data	input-output model	0.74% to 1.50%
MaCurdy and McIntyre (2001)	1996 to 1997 US SIPP and Census data: macro level data	input-output model	0.25%
	food industry data		0.80% to 1.20%
FLSA (1965 and 1969)	1961 and 1967 US Southern and non-Southern industry data	difference-in-difference	no effect
Wessels (1980)	1961 and 1967 US Southern and non-Southern industry data: manufacturing	difference-in-difference	no effect
	services		2.71%
Katz and Krueger (1992) and	1992 US New Jersey and Pennsylvania fast-food industry data	difference-in-difference	no effect
Card and Krueger (1995)	1990-1991 US Texas fast-food industry data	difference-in-difference	imprecise and mixed
	1990-1991 US CPI and ACCRA data	regression analysis	<4.00%
Spriggs and Klein (1994)	1991 US fast-food industry data	difference-in-difference	no effect
Aaronson (2001)	1978 and 1997 US BLS and ACCRA data Canada StatCan data	regression analysis	0.72% to 0.74%.
MacDonald and Aaronson (2002)	1995 to 1997 US CPS, MSA and CPI (Food Away from Home component) data	regression analysis	0.73% to 0.74%.
Machin et al. (2003)	1998 to 1999 UK residential care homes industry data	regression analysis	no effect
Draca et al. (2005)	1987 to 1991 UK RPI and 1992 to 2003 PPI restaurants, takeaway and canteens data	regression analysis	no effect

[1] The data period is not clearly specified in Falconer (1978) but it is understood to be from 1938 to 1978.

[2] All estimates are significant at the usual levels of significance unless otherwise indicated. For more details see Sections 3.1 to 3.5 or the specific studies.