Compensating Wages under Different Exchange Rate Regimes[*]

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January 26, 2004

Abstract

This paper analyses the interconnectedness between developing countries domestic wage levels and their exchange rate choice. The theoretical model illustrates that differences in domestic wage levels are related to countries' exchange rate regimes. In particular, the level of domestic wages increases with the rigidity of the exchange rate regime. The empirical model explores the determinants of the domestic wage level in a cross-section of 38 developing countries. In line with the theoretical model, the economies under consideration experience a rise in the domestic wage level with an increase in the rigidity of their exchange rate regime.

JEL Classification: F330, F410

Keywords: Exchange Rate Regimes, Monetary Policy, Uncertainty

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1 Introduction

Differences in wage levels across countries are central to economic questions such as factor price equalisation, the relative living standards or migration of labour across regions and countries. An interesting finding in international economics is the empirical regularity that international wage levels across countries are positively related to the level of real income per capita (see Freeman and Oostendorp, 2000 as well as Dornbusch, Fischer and Samuelson, 1977).[1] By relating the wage setting behaviour to the exchange rate choice, this paper offers a further explanation for differing wage levels across countries. In particular, the implications of the exchange rate regime choice on the wage setting behaviour in developing countries is considered. So far, the ability of exchange rate regimes to influence wage rates across developing countries has not been investigated in much detail. Yet, the nominal exchange rate matters due to the presence of market distortions such as sticky prices or wages.

The first authors making their case for flexible exchange rates are Friedman (1953) and Mundell (1961). The authors argue that flexible exchange rates act as a 'shock absorber', which help to stabilise the economy when external shocks occur. In case of an external shock and sticky goods prices or sticky wages it is easier to adjust the nominal exchange rate than to wait until imbalances in the goods and labour market push the relative prices in the desired direction. Consequently, a floating exchange rate insulates the economy against external shocks. Additionally, a floating exchange rate allows a country's monetary policy to become independent of the nominal exchange rate. Thus, the country's monetary policy can be used to respond to real shocks which hit the economy.

Despite the importance of the exchange rate regime choice for developing countries, there is relatively little empirical work addressing their effects on domestic wage levels. Recent research has predominantly focused on exchange rates and their impact on labour markets. Branson and Love (1988) analyse exchange rate movements and manufacturing employment in the US. Their finding is that real US dollar appreciations are associated with a decline in employment in the durable goods sectors. Similarly, Gourinchas (1998) analyses exchange rate movements in relation to changes in employment for the US. His main finding is that US dollar depreciations lead to significant positive changes in gross employment. Goldberg and Tracy (2001) concentrate on the magnitude of wage sensitivity to movements in the US dollar. They establish that dollar fluctuations translate into more sensitive wages in the US. Little research has focused on exchange rate regimes and their impact on domestic wage levels.

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[1] One of the most common explanations for this relationship is based on the differences in labour productivity across sectors and countries.

This paper contributes to the existing literature by analysing the equilibrium effect of the exchange rate regime choice on domestic wage levels in developing countries. The paper argues that the exchange rate regime choice matters, since it influences the monetary authority's response to real shocks. Under floating exchange rates the monetary authority is able to accommodate real shocks. When the nominal exchange rate is inflexible, the monetary authority is unable to offset real disturbances. This creates uncertainty about the level of macroeconomic variables, such as consumption or labour supply. Consequently, households under fixed exchange rates require a wage premium relative to households under floating exchange rate regimes to compensate for the presence of uncertainty in the economy. This might especially be true in countries with less developed financial markets where only a limited amount of assets is available to insure against the consequences of real shocks. Especially developing countries have incomplete financial markets and, therefore, do not participate in international risk sharing. Thus, to offset uncertainty households in developing countries might use wages as a principal insurance mechanism.

To provide a basis for the empirical analysis this paper uses a theoretical framework on optimal wage setting under different exchange rate regimes. In particular, a general equilibrium approach is utilised to analyse a stochastic model with preset wages and imperfect competition. The domestic country is subject to productivity shocks and has the choice to either peg or float its nominal exchange rate. A comparison between the two exchange rate regimes shows that the monetary authority cannot resolve uncertainty about the level of macroeconomic variables under a pegging exchange rate regime.[2] This affects the expected utility of households. The more volatile the expected real shock the higher will be the expected utility costs. Households take those expected utility costs into account when deciding about their preset wages. As a consequence, households require a wage premium relative to households under floating exchange rate regimes.

To empirically test the hypothesis that the level of wages increases with the rigidity of the exchange rate regime, newly constructed data sets by Freeman and Oostendorp (2000) and Reinhart and Rogoff (2003) are utilised. The former authors transform the International Labour Organisation's (ILO) wage survey into a consistent data file on wage payment over the time period 1983 to 1998. Reinhart and Rogoff develop a new approach to reclassify historical exchange rate regimes over the period 1946 to 2001. Their de facto classification will be compared with the International Monetary Fund's (IMF) Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER, 2002), known as the de jure classification. The comparison between

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[2]This uncertainty argument was first established by Obstfeld and Rogoff (2000). A similar argument with respect to differing price levels across countries can be found in Broda (2003), Corsetti and Pesenti (2001) as well as Devereux and Engel (2000).

the two approaches allows an empirical assessment of the paper's hypothesis, using different exchange rate regime classifications.

The remainder of this paper is structured as follows: The theoretical background, which follows the recent new open economy macroeconomics literature, is delineated in the next section. Section 3 discusses the data used and presents the empirical strategy. The empirical estimates examine the determinants of the domestic wage level in a cross-section of developing economies, using the exchange rate regime variable in conjunction with a set of control variables which have been employed in the literature. Section 4 concludes by providing a brief summary of the findings.

2 The Model

This section develops a stochastic new open economy macroeconomics model.[3] It consists of a small open economy, Home (H), and the rest of the world, named Foreign (F). The model features optimising households, nominal rigidities and monopolistic competition. There is only one period and no ex-ante trade in state contingent assets.[4] Agents set their wage after the exchange rate regime has been defined. However, wages are set in advance before real shocks, production and consumption are realised. Productivity shocks are the only possible disturbance. Households then supply labour that firms demand once uncertainty is revealed and decide about money balances and consumption. Production in each country takes place out of traded and nontraded goods. The monetary policy is defined to be one with commitment. This is a reasonable assumption since the systematic component is more important than the surprise element in monetary policy (Lane, 2002). It is assumed that the monetary authority can observe the productivity shock, k, after wages are set and then sets the money supply in response.

Preferences, Consumption Indexes and Firms

There is a continuum of economic agents, indexed by $i \, \epsilon \, [0, 1]$. For each agent i the periodic utility function is given by

$$U(i) = \log C(i) + \log \frac{M(i)}{P} - k \frac{L(i)^\nu}{\nu}. \tag{1}$$

Households associate utility benefits from the consumption index $C(i)$, from holding real balances $\frac{M(i)}{P}$ and disutility from the obligation to supply labour effort, $L(i)$, to the traded and nontraded

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[3] See also Corsetti and Pesenti (2001), Devereux (2002) as well as Obstfeld and Rogoff (2000). For a survey on the new open economy macroeconomics literature see Lane (2001).

[4] Lewis (1996) provides empirical evidence for this assumption. The main conclusions do not depend on the absence of dynamics.

good firms. The elasticity of marginal disutility from work effort is given by $\nu - 1$, where $\nu > 1$. The assumption that $\nu > 1$ ensures that the labour supply schedule is downward sloping. In general, a rise in ν makes the labour supply more inelastic. A random shift in the marginal disutility of work effort, $k > 0$, can be seen as an inverse national productivity shock which affects productivity in the traded and nontraded sector equally.[5] A shock to productivity reflects the uncertainty in the model.

Total labour effort, $L(i)$, is given by labour effort in the home traded good sector, $L_H(i, z)$, and nontraded sector, $L_N(i, z)$. Each household acts as a monopolistic supplier of a variety of labour services, z, to the homogeneous traded and nontraded good sector. Total labour effort equals $L(i) = \int_0^1 L_H(i, z) dz + \int_0^1 L_N(i, z) dz$. The nominal wage in the two sectors is defined as $W(i)$. While wages are preset, prices of all goods are completely flexible and can be changed in response to market conditions. Foreign agents, (F), have symmetric preferences and are denoted by $*$. Agent (i) faces the ex post budget constraint:

$$PC(i) + M(i) - M_0 = T + W(i) \left(L_H(i, z) + L_N(i, z) \right) + \Pi(i), \tag{2}$$

where $\Pi(i)$ denotes total profits and $T = M(i) - M_0$ are per capita transfers in nominal terms. The household receives the profits, $\Pi(i)$, from the ownership of the firm. M_0 reflects the initial money holdings in the economy. Note that $PC(i) = P_H C_H(i) + P_F C_F(i) + P_N C_N(i)$. For any household i the overall consumption index is given by $C(i) = C_T(i)^\gamma C_N(i)^{1-\gamma}$. The implication of the consumption index is that the intratemporal elasticity of substitution equals *unity*. The parameter $0 < \gamma < 1$ represents the preference for the traded good C_T. C_T reflects the consumption of tradable goods, $C_T(i) = C_H(i)^\eta C_F(i)^{1-\eta}$. The relative preferences between the home produced good, $C_H(i)$, and foreign produced traded good, $C_F(i)$, are reflected by the parameter $0 < \eta < 1$. The nontraded consumption is characterised by $C_N(i)$. The consumption price index for household (i) is given by $P = \frac{P_T^\gamma P_N^{1-\gamma}}{\gamma^\gamma (1-\gamma)^{1-\gamma}}$. In turn, the traded goods price index equals $P_T = \frac{P_H^\eta P_F^{1-\eta}}{\eta^\eta (1-\eta)^{1-\eta}}$. It is assumed that the law of one price holds such that $P_H = SP_H^*$ and $P_F = SP_F^*$. Maximising the objective function (1) subject to equation (2) and the trade balance condition yields the total demand functions:

$$C_T(i) = \gamma \left(\frac{P_T}{P} \right)^{-1} C(i) \text{ and } C_N(i) = (1 - \gamma) \left(\frac{P_N}{P} \right)^{-1} C(i), \tag{3}$$

whereby $C_H(i) = \eta \left(\frac{P_H}{P_T} \right)^{-1} C_T(i)$ and $C_F(i) = (1 - \eta) \left(\frac{P_F}{P_T} \right)^{-1} C_T(i)$ hold. The production

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[5] As in Obstfeld and Rogoff (2000), the variable $L(i)$ denotes efficient labour rather than the hours worked, $H(i)$. As a consequence, $H(i) = k^{\frac{1}{\nu}} L(i)$. Hence, technology is labour augmenting. A negative productivity shock, a rise in k, allows the household to produce less in a given amount of time.

technology of a fixed unit mass of firms in the traded, $Y_H(i) = L_H(i)$, and nontraded goods sector, $Y_N(i) = L_N(i)$, uses traded and nontraded labour input, $L_H(i) = \left(\int_0^1 L_H(i,z)^{\frac{\theta-1}{\theta}} dz\right)^{\frac{\theta}{\theta-1}}$ and $L_N(i) = \left(\int_0^1 L_N(i,z)^{\frac{\theta-1}{\theta}} dz\right)^{\frac{\theta}{\theta-1}}$. The foreign country has similar linear production technologies. Labour is differentiated across households and each household works for each firm in the two sectors. $L_H(i)$ and $L_N(i)$ are the aggregate of the individual labour supply in the two sectors. The elasticity of substitution between any two heterogeneous workers equals $\theta > 1$. The resource constraints for traded and nontraded goods produced in country H are $Y_H(i) = \int_0^1 C_H(i)di + \int_0^1 C_H^*(i)di$ and $Y_N(i) = \int_0^1 C_N(i)di$. Profits of the firms in the traded and nontraded sectors are defined by $\pi_H(z) = P_H Y_H(i) - \int_0^1 W(i)L_H(i,z)dz$ and $\pi_N(z) = P_N Y_N(i) - \int_0^1 W(i)L_N(i,z)dz$. The implicit labour demand schedule in the traded and nontraded good sector can be derived by differentiating the profit functions with respect to $L_H(i,z)$ and $L_N(i,z)$. Consequently,

$$W(i) = \left(\frac{L_H(i,z)}{L_H(i)}\right)^{-\frac{1}{\theta}} P_H \text{ and } W(i) = \left(\frac{L_N(i,z)}{L_N(i)}\right)^{-\frac{1}{\theta}} P_N \text{ holds.} \tag{4}$$

Optimisation and the Optimal Preset Wage

Given the profit income from the ownership of the firms as well as prices and preset wages, the household (i) would like to divide income between consumption and money holdings. Maximising the utility function, equation (1), subject to the budget constraint outlined in equation (2), the first order conditions for consumption and nominal money balances are obtained: $\frac{1}{PC(i)} = \lambda$, and $\frac{1}{M(i)} = \lambda$. $\frac{1}{\lambda}$ measures the marginal utility of nominal wealth. The optimal consumption is influenced by real money holdings. Since money has a value only for the current period, households equate marginal utility from holding money to the opportunity costs of acquiring it:

$$C(i) = \frac{M(i)}{P}. \tag{5}$$

Each household supplies labour to the traded and nontraded goods sector and faces downward sloping demand curves which are given by equation (4). Household (i) does not know the state of economy. Therefore, he chooses its preset wage to maximise expected utility. The agents meet the demand they face at the preset wage once uncertainty is resolved. The optimal wage can be derived from the maximisation of equation (1) in expected terms subject to equations (2) and (4).[6] The optimal wage in the two sectors will satisfy

$$W = \frac{\theta}{\theta-1} \frac{E_{-1}\left(kL^\nu\right)}{E_{-1}\left(\frac{L}{M}\right)}. \tag{6}$$

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[6] Here the subscript (i) is ignored.

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The right-hand side of equation (6) shows that households set their wages equal to the marginal costs of supplying an additional unit of labour relative to the marginal utility of consuming an additional unit of goods, $PC = M$, and the markup $\frac{\theta}{\theta-1}$. The marginal costs depend on the inverse productivity shock, k. The expected utility gain from a small reduction in wage, $\left(E_{-1}\left(\frac{M}{L}\right)\right)^{-1}(\theta-1)$, has to equal the expected utility cost from higher work effort, $\frac{E_{-1}(kL^\nu)}{W}\theta$. The cost of higher work effort increases in expected labour supply, $E_{-1}\left(L^\nu\right)$. Consequently, the incentive to reduce wages is smaller when labour is more volatile. A rise in productivity, a fall in k, reduces the marginal costs and stimulates output.

Equilibrium

The equilibrium for any monetary policy rule is represented by the goods market clearing in the home, $L_H = \eta\gamma\frac{P}{P_H}(C + C^*)$ and $L_N = (1-\gamma)\frac{P}{P_N}C$, as well as foreign country, $L_F^* = (1-\eta)\gamma\frac{P}{SP_F^*}(C + C^*)$, utility maximisation by households and a balanced government budget.[7]

The closed form solution of the rational expectation equilibrium of the model for a given path of the money stock and a given foreign wage level, W^*, and money supply, M^*, equals

$C = \eta^\gamma \left(\left(\frac{\gamma M}{W}\right)^\eta \left(\frac{\gamma M^*}{W^*}\right)^{1-\eta}\right)^\gamma \left(\frac{(1-\gamma)M}{W}\right)^{1-\gamma}$	$W = \left(\frac{\theta}{\theta-1}\right)^{\frac{1}{\nu}} (E_{-1}(kM^\nu))^{\frac{1}{\nu}}$
$L = \frac{M}{W}$	$P_H = P_N = W$
$L_H = Y_H = \frac{\gamma M}{W}$	$P = \left(W^{1+\gamma(\eta-1)}\right)(SW^*)^{(1-\eta)\gamma}$
$L_N = Y_N = \frac{(1-\gamma)M}{W}$	$S = \frac{1-\eta}{\eta}\frac{M}{M^*}$

The equilibrium nominal exchange rate, $S = \frac{1-\eta}{\eta}\frac{M}{M^*}$, has implications for the choice of the exchange rate regime: Although η is parametric, it is assumed temporarily that it could vary. A fall in η implies a depreciation of the nominal exchange rate. Under a peg the monetary authority has to respond procyclically to movements in the preference parameter η. Hence, a contractionary monetary policy is necessary to overcome the rise in the nominal exchange rate. The same is true for a decline in the rest of the world's money supply, M^*. No response is required to a productivity shock k.[8] Under floats the economy is independent of external shocks since the nominal exchange rate insulates the economy against movements in η and M^*. For the remaining part of the analysis η remains parametric and $M^* = 1$ is the same for country H, regardless of its choice to float or peg its nominal exchange rate.

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[7]Using equation (3) it can be shown that $P_H Y_H = \gamma PC = P_T\, C_T$ holds. The same is true for the foreign country such that $(1-\eta)\,C_T = \eta C_T^*$. The implication is that the consumption levels of traded goods are in constant proportion to each other.

[8]It is assumed that k and k^* are uncorrelated.

The optimal wage in equilibrium, $W = \left(\frac{\theta}{\theta-1}\right)^{\frac{1}{\nu}} (E_{-1}(kM^\nu))^{\frac{1}{\nu}}$, depends on the distribution of the money stock in relation to productivity. Money supply, M, can be expressed as a log-linear transformation of k, and, therefore, a lognormal distribution of the two variables is assumed, whereby the mean value of $\log k = \kappa$, $E_{-1}(\kappa)$, and $\log M = m$, $E_{-1}(m)$, is assumed to equal zero.[9] Thus, the expected equilibrium wage equals

$$E_{-1}\left(\log W\right) = \frac{1}{\nu}\left(\Omega + \frac{\sigma_\kappa^2}{2} + \frac{\nu^2}{2}\sigma_m^2 + \nu\sigma_{\kappa,m}\right), \text{ where } \Omega = \log\left(\frac{\theta}{\theta-1}\right).$$

A rise in the volatility of the money supply, reflected by its variance $\sigma_m^2 > 0$, will increase the equilibrium nominal wage. This is due to the fact that the household likes to keep its expected labour supply, $E_{-1}\left(L^\nu\right)$, constant. According to the equilibrium labour supply equation, $L = \frac{M}{W}$, labour increases linearly with the nominal money supply. Hence, households attach more weight to high values of money than to low ones. They set higher nominal preset wages, the more money is volatile. Furthermore, a negative covariance between productivity and money supply, $\sigma_{\kappa,m} < 0$, provides a hedge against the uncertain realisation of the productivity shock. Since real wages tend to be high when productivity is low, households set a lower nominal wage when the covariance is negative. A higher variance in the productivity shock k, $\sigma_\kappa^2 > 0$, increases the expected utility costs from work effort and, hence, wages in the economy.

Wage Differentials under different Exchange Rate Regimes

In order to assess whether the equilibrium level of wages differs with the exchange rate regime choice the monetary policy rules have to be defined.

Under a fixed exchange rate regime the monetary policy rule equals $M_{Peg} = M_0$, so that the money stock remains constant.

Given the equilibrium nominal exchange rate a constant money stock reflects the optimal response of the monetary authority under a fixed exchange rate regime to the productivity shock, k. Consequently, the monetary authority cannot respond to any productivity shock and the covariance between the money stock and productivity, $cov(\kappa, m) = \sigma_{\kappa,m}$, equals zero.

Under floating exchange rates the monetary policy is independent of the nominal exchange rate and can decide on an efficient monetary policy rule that accommodates the real shock in the economy. An efficient monetary policy rule, defined here as replicating the flexible wage equilibrium, reacts procyclically to changes in productivity so that $M'(k) < 0$ and $M''(k) > 0$.[10]

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[9] The random vector $\underline{X} = (X_1, ..., X_N)$ is normally distributed with a mean vector $\boldsymbol{\mu}$ and a variance-covariance matrix Σ. Then, for a moment generating function, $G_{\underline{X}}(\underline{l})$, a multinormal distribution of the form $G_{\underline{X}}(\underline{l}) = E(\exp(\underline{l}\cdot\underline{X}) = \exp(\underline{l}\cdot\boldsymbol{\mu} + \frac{1}{2}\underline{l}' \cdot \Sigma \cdot \underline{l})$ is assumed.

[10] See also Ireland (1996) and Kim and Henderson (2002).

In particular an optimal monetary policy rule under floating exchange rates is mirrored in the following assumption:

In a floating exchange rate economy the monetary authority responds to the productivity shock, k, and adjusts its money stock as follows: $M_{Float} = \frac{M_0}{k^{\frac{1}{\nu}}}$, *where* $M'_{Float}(k) < 0$ *and* $M''_{Float}(k) > 0$.

The monetary authority adopts a procyclical monetary policy under floats when responding to a productivity shock.[11] It follows that the covariance between the domestic money supply and productivity shock must be negative, so that $cov(\kappa, m) = \sigma_{\kappa,m} < 0$. The negative covariance between productivity and money supply, $\sigma_{\kappa,m}$, provides a hedge against the uncertain occurrence of the productivity shock. More precisely, the monetary policy rule offsets the productivity shock in the floating exchange rate economy and resolves uncertainty in this country. Thus, the monetary policy rules affect the expected level of utility under the two exchange rate regimes.

Proposition 1 *The expected utility is higher under floating exchange rates than under fixed exchange rates:* $E_{-1}(U_{Float}) > E_{-1}(U_{Peg})$.

Proof. The utility function, equation (1), in expected terms reads $E_{-1}(U) = E_{-1}(log(C)) + E_{-1}(log(\frac{M}{P})) - E_{-1}(k\frac{L^\nu}{\nu})$. The equilibrium consumption, C, the price level, P, and labour supply, L, are already defined. Substituting M under floats with $M_{Float} = \frac{M_0}{k^{\frac{1}{\nu}}}$ and using the fact that $F_C = \log\left[\eta\gamma\left(\frac{\gamma}{W^*}\right)^{(1-\eta)\gamma}\left(\frac{\theta-1}{\theta}\right)^{\frac{1}{\nu}(\eta\gamma+(1-\gamma))}\right]$, $F_P = \log\left[\left(\frac{\theta}{\theta-1}\right)^{\frac{1}{\nu}(\gamma(\eta-1)+1)}(W^*)^{(1-\eta)\gamma}\right]$ as well as $F_L = \left(\frac{\theta-1}{\theta}\right)$ provides the expected utility level under floating exchange rates:

$$E_{-1}(U_{Float}) = F_C + \log\left[\gamma^{n\gamma}(1-\gamma)^{1-\gamma}\right] + \log M_0 - \left(F_P + \log\left[M_0\left(\frac{1-\eta}{\eta}\right)^{(1-\eta)\gamma}\right]\right) - F_L. \tag{7}$$

Under pegs the monetary rule equals $M_{Peg} = M_0$. Thus, the expected utility under fixed exchange rates reads

$$\begin{aligned} E_{-1}(U_{Peg}) &= F_C + \log\left[\gamma^{n\gamma}(1-\gamma)^{n\gamma}\right] + \log M_0 - \left(F_P + \log\left[M_0\left(\frac{1-\eta}{\eta}\right)^{(1-\eta)\gamma}\right]\right) - F_L \\ &\quad - 2(\gamma\eta - \gamma + 1)\frac{\sigma_\kappa^2}{2}. \end{aligned} \tag{8}$$

The difference between equation (7) and (8) reflects the expected relative welfare gains under

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[11] In the flexible wage equilibrium the equilibrium labour supply condition holds in any state of nature and without expectations. To see that this is also the case in Assumption 1 consider its monetary policy rule: $L = \frac{M}{W} = \frac{M_0}{k^{\frac{1}{\nu}}}\left(\frac{\theta-1}{\theta}\right)^{\frac{1}{\nu}}\left(E_{-1}(k\left(\frac{M_0}{k^{\frac{1}{\nu}}}\right)^\nu)\right)^{-\frac{1}{\nu}} = \left(\frac{\theta-1}{\theta}k^{-1}\right)^{\frac{1}{\nu}}$. That is, under flexible wages the equilibrium labour supply is only affected by fluctuations that would arise in a flexible wage world. The uncertainty is resolved in a flexible wage world.

floating exchange rates:

$$E_{-1}\left(U_{Float}\right) - E_{-1}\left(U_{Peg}\right) = \left(1 - \gamma\left(1 - \eta\right)\right)\sigma_{\kappa}^2 > 0.$$

This establishes the claim made in Proposition 1. ∎

The relative welfare gains under a floating exchange rate regime increase in the variance of the productivity shock, k. In other words, the relative expected utility under fixed exchange rates declines with the volatility of the productivity shock. Proposition 1 illustrates that a procyclical monetary policy becomes the optimal response in relative welfare terms when productivity changes and wages are preset. A procyclical change in the domestic money stock under floating exchange rates accommodates the productivity shock and eliminates uncertainty in the economy. Thereby it stabilises expected consumption and minimises the expected fluctuations in labour supply. This eliminates the expected utility costs from the presence of uncertainty. Consequently, the floating exchange rate economy experiences a higher expected level of utility relative to the fixed exchange rate regime. As a precurser to the empirical analysis, the wage level of the domestic country is defined.

Definition 1 *The domestic wage level equals the average domestic wage level expressed in foreign currency, S. Hence, the domestic wage level is equivalent to*

$$Domestic\ Wage\ Level\ (DWL) = \frac{W}{S}.$$

Definition 1 compares the cost of labour, expressed by wages, across countries, and will be used in the empirical part to analyse differences in the wage level under different exchange rate regimes.[12]

From the monetary policy rule M_{Peg} it becomes clear that the monetary authority does not respond to any changes in productivity under fixed exchange rates. Accordingly, no correlation between money stock, M, and the productivity shock, k, occurs. The monetary authority does not allow to hedge against the uncertain realisation of the productivity shock and, therefore cannot resolve uncertainty. Under a floating exchange rate regime the monetary authority's purpose is to accommodate the productivity shock. It follows that the covariance between the domestic money supply and productivity shock must be negative, so that $cov(\kappa, m) = \sigma_{\kappa,m} < 0$. As a result, the monetary rule resolves uncertainty in the economy.

Proposition 2 *The expected domestic wage level under*

1. *fixed exchange rates rises with the variance of the productivity shock, σ_{κ}^2.*

2. *floating exchange rates is independent of the productivity shock.*

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[12] A similar terminology has been applied in the empirical literature on price levels. See Rogers (2001) among others.

Proof. To derive part 1 of Proposition 2, it is assumed that households under fixed exchange rates take the monetary policy rule under pegs into account when deciding about their preset wage. Then the domestic wage level equals $DWL_{Peg} = \left(\frac{\theta}{\theta-1}\right)^{\frac{1}{\nu}} \frac{(E_{-1}(kM_0^{\nu}))^{\frac{1}{\nu}}}{\frac{1-\eta}{\eta}M_0}$ and, thus,

$$E_{-1}\left(\log DWL_{Peg}\right) = \frac{1}{\nu}\frac{\sigma_{\kappa}^2}{2} + \frac{\Omega}{\nu} - \Phi, \text{ where } \Phi = \log\frac{1-\eta}{\eta}. \tag{9}$$

The claim made in part 1 of Proposition 2 immediately follows from equation (9).

To establish part 2 of Proposition 2, recall that households account for the monetary rule under floating exchange rates. The domestic wage level equals $DWL_{Float} = \left(\frac{\theta}{\theta-1}\right)^{\frac{1}{\nu}} \frac{\left(E_{-1}(k\left(\frac{M_0}{k^{\frac{1}{\nu}}}\right)^{\nu})\right)^{\frac{1}{\nu}}}{\frac{1-\eta}{\eta}\frac{M_0}{k^{\frac{1}{\nu}}}}$.
It follows that

$$E_{-1}\left(\log DWL_{Float}\right) = \frac{\Omega}{\nu} - \Phi. \tag{10}$$

Equation (10) establishes the claim made in part 2 of Proposition 2. ∎

As the monetary authority maintains a fixed exchange rate it cannot offset productivity disturbances. This creates uncertainty, σ_{κ}^2, in the economy and causes utility costs to fluctuate with the productivity disturbance (see equation (8)). Since wages are preset households cannot adjust wages after the productivity shock has occurred. Consequently, to be compensated for the volatility of the productivity shock households under fixed exchange rates require a wage premium, denoted by σ_{κ}^2. Since the monetary authority resolves uncertainty under a floating exchange rate regime, households do not require any compensation for the presence of uncertainty through wages. As a result, the expected domestic wage is constant under floating exchange rate regimes. Applying Proposition 2, the difference between equation (9) and (10) shows that the relative wage differential, $E_{-1}\left(\log DWL_{Peg}\right) - E_{-1}\left(\log DWL_{Float}\right) = \frac{\sigma_{\kappa}^2}{2\nu}$, depends on the magnitude of uncertainty.[13] The intuition for this result is that a fixed exchange rate economy adopts a passive monetary policy rule relative to the floating exchange rate economy, which causes the expected utility costs to fluctuate with the productivity shock, k, under pegs. To be compensated for this, households require a wage premium relative to floating exchange rate economies. Hence, the following corollary should hold:

Corollary 1 *The equilibrium domestic wage level increases with the inflexibility of the exchange rate regime. Consequently, $E_{-1}\left(\log DWL_{Peg}\right) > E_{-1}\left(\log DWL_{Float}\right)$.*

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[13] At this point it is worth to note that the results derived are also valid for an external shock in form of η or a foreign money supply shock, M^*. A proof is available on request from the author.

3   Empirical Evidence

This section attempts to empirically assess Corollary 1 by presenting the statistical inference of developing countries' wage level in relation to their adopted exchange rate regime. The paper concentrates on the period 1983 to 1998. The sample consists of 38 developing countries (see Table 1).

Data

To obtain a measure of the level of domestic wages across developing countries, this paper explores Freeman and Oostendorp's (2000) occupational wage data set. The authors transform the survey of wages, conducted by the ILO, into a consistent data file on pay in 161 occupations from 1983 to 1998. Since specific occupations vary across countries and years, a comparison between exactly the same occupation across countries would reduce the sample size too much. Thus, this paper takes another approach and calculates a yearly average of a country's domestic wage level. Observations on wages are treated as samples from the distribution of occupational wages for each country, rather than as estimates of wages for a specific occupation.[14] To construct an average wage rate of a country in a particular year, this paper concentrates on countries that report on the same occupations over time.[15] To analyse differences in wage levels across exchange rate regimes, the level of domestic wages is expressed in terms of a single currency, namely the US dollar. The deflated wages allow to capture the cost of labour across countries.

Two exchange rate classifications are explored in the empirical analysis. This paper follows the recent work by Reinhart and Rogoff (2003) and the IMF's AREAER (2002) to classify the exchange rate regimes of the 38 developing countries of interest. The AREAER report is based on the publicly stated commitment of the authorities in the countries in question. This approach is known as the de jure analysis and will be compared with the de facto classification by Reinhart and Rogoff. The authors utilise market-determined parallel exchange rates. The two classifications form the basis of the following empirical analysis. The de facto approach uses the *fine* classification codes by Reinhart and Rogoff, so that the most rigid peg is denoted by 1 and the most flexible exchange rate regime by 14. The IMF classifies eight exchange rate regimes. Similar to the de facto classification, the most rigid exchange rate arrangement equals 1 and the most flexible equals 8 in the de jure classification.

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[14] This paper treats occupations as units of observations. This assumption is valid as long as one is concerned with the structure of wages. However, it is true that the distribution of occupational wages will differ from the distribution of individual wages if occupations have different amounts of employees (see Freeman and Oostendorp, 2000).

[15] For example, if Mexico consistently reports on 23 occupations over time, only these 23 occupation codes are used. On average the analysed countries report 50 occupations per year. Wages are expressed per 1000 US $.

Additionally, a set of control variables is introduced. The literature on factor price equalisation defines income levels as the key determinant for differences in factor prices across countries (see for example Balassa, 1964). Freeman and Oostendorp (2000) establish that domestic wage levels tend to rise with the level of income per capita. To control for differing income levels across developing countries the variable *GDP per capita* is added to the regressional analysis. It is measured in constant US dollars and taken from the World Development Indicators (WDI, 2002).[16]

A further control variable is the extent to which a country trades. The theorem by Stolper and Samuelson (1941) predicts that countries with high trade shares should experience a factor price equalisation towards the world average. Thus, trade lowers the relative dispersion in wages between less developed countries with relatively low levels of skills. The trade theory also allows factor prices to differ if countries operate under different technologies or degrees of competition. To capture the degree of openness to trade, the paper utilises the ratio of exports of goods and services relative to GDP (WDI, 2002) as an *openness* measure.

To account for macroeconomic heterogeneity of countries, an additional control variable is introduced. The *size* of a country is particularly important. Larger countries may be less vulnerable to real shocks, due to diversified production. However, a small open country may be able to adjust to changes in the macroeconomic environment more quickly and flexibly. A country's exchange rate regime choice is also linked to its size, since small countries may find it easier to lock onto a large one, than would two countries of similar size. The country's size is measured by total GDP, which is obtained from the WDI (2002).[17]

The empirical model also controls for macroeconomic fundamentals across countries. Therefore, the *volatility of money* supply and the rate of *inflation* in the economy will be added to the regression analysis. Including the rate of inflation in the empirical model allows to capture a possible output-inflation trade-off. The rate of inflation relates the level of domestic wages to changes in prices. If price inflation is too high, (preset) domestic wage levels should decline and vice versa. The volatility of money might account for the stance of the monetary policy across countries. Especially countries which try to target inflation should experience a less volatile money stock. If the monetary authority aims at not only targeting inflation but also unemployment money supply becomes less stable over time. This should influence expectations and the domestic wage level of countries. The volatility of money supply is calculated by a five

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[16] In the empirical analysis similar results are obtained, when the real GDP per capita measure by the Penn World Table 5.6. is used.

[17] An alternative measure of country size would be total population. Applying this variable in the empirical analysis does not change the main results of the paper.

year rolling standard deviation of the monetary aggregate M2, utilising the IMF International Financial Statistics (IFS, 2001). The rate of inflation is obtained from the WDI (2002).

A first diagnostic of the data is provided in Table 2, where the summary statistic differentiates between fixed, intermediate and floating exchange rate regimes.[18] The de facto and de jure classification show that, on average, developing countries with an intermediate exchange rate regime have higher domestic wage levels. On average, fixed exchange rate regimes have less volatile domestic wage levels than floating and intermediate regimes. Concentrating on GDP per capita, developing countries with an intermediate or floating exchange rate provide evidence for smaller deviations of GDP per capita. To investigate the empirical relationship between the domestic wage level and exchange rate regimes across developing countries in more detail the next section continues with a regressional analysis.

Cross-Sectional Analysis

The theoretical priors suggest an equilibrium relationship between the domestic wage level and the exchange rate regime choice of developing countries. Therefore, a cross-sectional approach is utilised over the time period 1983 to 1998. This type of approach abstracts itself from short-run fluctuations of the macroeconomic variables. The cross-sectional analysis also deals with the potential criticism that the results obtained only reflect the short-run effects of changes in the exchange rate regime on the level of domestic wages. For example, the economic performance that may arise from a sudden regime shift, for instance a collapse of the currency, may be wrongly assigned to the floating exchange rate regime although it is the result of the preceding periods of the regime change. The cross-sectional approach circumvents this by averaging the exchange rate variable over the period 1983 to 1998. The cross-sectional analysis allows also to focus on the level of variables, as suggested by the general equilibrium model outlined in the previous section.[19] Accordingly, the basic specification of the regression analysis can be written as follows:

$$DWL_i = \alpha + \beta y_i + \gamma Open_i + \delta ExR_i + \boldsymbol{\psi}' \mathbf{X}_i + \varepsilon_i \tag{11}$$

DWL is the wage level of country i, expressed in a common currency. First, DWL_i is regressed

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[18] For the IMF classification the paper follows Frankel (1999). He categorises exchange rate regimes into three types: Currency unions, currency boards and truly fixed exchange rates can be specified as *fixed exchange rates*. *Intermediate regimes* comprise crawling pegs (adjustable pegs, crawling pegs and basket pegs) and dirty floats (target zone/bands or managed floats). Free floats represent a *pure float* regime. A similar approach has been taken for the de facto classification by Reinhart and Rogoff (2003).

[19] Most of the existing literature on exchange rate regimes follows the prediction of the Dornbusch-Mundell-Fleming model and concentrates on changes and volatilities in the variables.

on the *log* of GDP per Capita, y_i, the exchange rate variable, ExR_i and the openness measure, $Open_i$. Second, size is added to the regressional analysis. Lastly, volatility of money and inflation are introduced. The last three regressors are included in the vector $\mathbf{X}_i$. All variables are simple averages over the period 1983 to 1998. Results of White's (1980) test for heteroskedasticity in the residuals from the OLS regression provide some evidence for the presence of heteroskedasticity. The standard errors are therefore obtained from White's consistent covariance matrix.

De Jure Classification   The estimation of the domestic wage level equation depicts a negative relationship between the exchange rate regime variable and the average level of domestic wages across countries throughout columns (1) to (3) of Table 3. The more rigid the exchange rate regime, the higher the average domestic wage level of developing countries. The estimated δ parameter of the exchange rate regime variable, ExR_i, is statistically significant when the standard control variables and volatility of money and inflation are added. In line with the theoretical predictions, the average domestic wage level increases the less flexible the exchange rate regime is.

A negative relationship between wages and the flexibility of the exchange rate regime exists when variations in wealth and openness across developing countries are controlled for. The estimated β parameter of GDP per capita is statistically significant at the one percent level. The three variables are able to explain 42 percent of the variations in the data. The point coefficient of 0.09 means that a 10 percent improvement in the average domestic GDP per capita raises the average domestic wage level by 0.9 percentage points. The estimated openness coefficient, γ, is also statistically significant at the one percent level. A 10 percentage point increase in a country's openness raises the domestic wage level by 0.02 percentage points. Thus, a higher trade share increases the overall wage level. This might offer some support for the Stolper and Samuelson theorem, which predicts that more open developing economies should experience a factor price equalisation towards the world average. When controlling for macroeconomic heterogeneity, the exchange rate regime coefficient, δ, remains negative in sign and statistically significant at the five percent level (column (2)). The volatility of money and inflation, column (3), enter the regression analysis with positive signs. Controlling for the stance of monetary policy reduces the point estimate of the exchange rate variable. However, the estimated exchange rate regime coefficient remains statistically significant and negative in sign. The estimated positive coefficient on volatility of money stock implies that a more volatile money stock increases the domestic wage level in developing countries.

The findings for the de jure classification can be summarised as follows: The exchange rate regime variable plays an important role in explaining the domestic wage level across developing

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countries. When controlling for variations in wealth, openness and size as well as money volatility and inflation, wages are positively affected by the rigidity of the nominal exchange rate, which confirms the theoretical priors discussed above. Consider two developing countries with distinct, however, closely related exchange rate regimes (i.e. the countries would for example have exchange rate regimes defined as 3 and 4 or 6 and 7). If the countries exhibit the same size, income level and degree of openness, the average monthly wage differential per year will be approximately 37 US $.

Columns (4)-(6) of Table 3 present results on upper middle income economies, which should exhibit a more advanced wage setting behaviour.[20] Thus, a more pronounced relationship between the exchange rate regime choice and the level of domestic wages in this group of countries should be expected. The exchange rate regime variable, ExR_i, has a negative association with the level of domestic wages in upper middle income developing countries. The estimated ExR_i coefficient is statistically significant throughout columns (4) to (6). As for the complete developing country sample, the estimated negative exchange rate coefficient implies that the average domestic wage level in upper middle income economies is higher when the exchange rate regime is more rigid. Overall, the results obtained are in line with the findings for the complete developing country sample, when macroeconomic heterogeneity, volatility of money and inflation are controlled for. Controlling for macroeconomic fundamentals does not add explanatory power to the empirical model but increases the point estimate of the ExR_i coefficient. Now two middle income economies with distinct but closely related exchange rate regimes are considered. Given that the countries exhibit the same size, income level and degree of openness the average monthly wage differential per year will be approximately 90 US $. Hence, the wage differential is more pronounced than for the complete developing country sample.

De Facto Classification　　The de jure approach constitutes the uncertainty of not knowing whether the actual policy in the country is consistent with the commitment stated in the AREAER. Thus, the results obtained above are compared to the de facto classification, which attempts to capture the actual exchange rate regime behaviour of countries. Columns (1) to (3) of Table 4 report the results for the complete developing country sample. Allowing for variations in the level of wealth and openness, wages are higher in developing countries the more rigid the exchange rate regime is. Throughout columns (1) to (3) the estimated coefficient on GDP per capita enters the regression specification with a statistically significant positive sign. This

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[20]Upper middle income economies are defined, utilising country classification code by the WDI (2002). The following countries are included: Antigua and Barbuda, Argentina, Chile, Costa Rica, Czech Republic, Gabon, Hungary, Mauritius, Mexico, Slovakia, South Korea, Latvia, Uruguay and Venezuela. Singapore is also included. Excluding Singapore from the sample does not change the statistical results.

indicates that richer countries tend to have higher domestic wage levels. Similarly, as for the de jure specification, the degree of openness influences domestic wage levels positively. Including size, volatility of money stock and inflation improves the explanatory power of the empirical model (see column (3)). 40 percent of the variations in the data are explained by the statistical specification. The statistically significant positive coefficient on the volatility of money illustrates that the domestic wage level of developing countries rises the more volatile the money supply is. Overall, the results obtained confirm the findings of the de jure classification. Similar to the de jure classification, a negative relationship between the exchange rate regime variable and the average level of domestic wages across countries is established. However, compared to the de jure classification the exchange rate regime coefficient loses its statistical significance in the developing country samples in columns (1) to (3).

Turning to the sub-sample of upper middle income economies in columns (4) to (6) of Table 4 a statistically significant negative relationship between the domestic wage level and the exchange rate regime variable is established. Thus, upper middle income economies experience higher domestic wage levels when their exchange rate regime becomes more rigid. When considering two middle income economies with distinct, however, closely related exchange rate regimes the average monthly wage differential per year will be approximately 38 US $ if the countries exhibit the same income level and degree of openness. Compared to the de jure specification the estimated coefficient on openness loses its statistical significance, even though it remains positive in sign. As for the overall sample, upper middle income countries with higher wealth per capita experience a higher domestic wage level. Including volatility of money and inflation to the regression analysis does not improve the explanatory power of the model but leaves the estimated exchange rate regime coefficient statistically significant and negative in sign. Overall, the regressional analysis confirms the theoretical priors that the domestic wage level increases with the inflexibility of the exchange rate regime.

4 Conclusion

This paper examines the effects of the exchange rate regime choice on the domestic wage level in developing countries. In addition to existing research, it explicitly illustrates that different exchange rate regimes can influence the domestic wage level of countries. The question posed in this paper is analysed in two steps: First, a formal model investigates the relationship between the exchange rate regime choice and the domestic wage level. Second, an empirical analysis of developing countries sheds light on the theoretical findings that the domestic wage level increases with the inflexibility of the exchange rate regime.

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The theoretical model adopts a general equilibrium approach to offer a possible explanation for differing wage levels across exchange rate regimes. The model illustrates that a fixed exchange rate regime creates uncertainty about the level of macroeconomic variables and thereby reduces the relative expected utility under fixed exchange rates. The presence of uncertainty translates into higher expected utility costs under fixed exchange rate regimes. Households take those expected utility costs into account when deciding about their preset wage and require a wage premium relative to households under floating exchange rate regimes.

In the light of the theoretical findings, the paper empirically analyses the relationship between the domestic wage level and the exchange rate regime choice in developing countries over the time period 1983 to 1998. The empirical findings show that the exchange rate regime plays a statistically significant role in explaining wage levels across countries. Using a number of standard control variables, such as GDP per capita, openness and size, wage levels are significantly negatively affected by the flexibility of the exchange rate regime. Hence, domestic wage levels increase with the rigidity of the exchange rate regime.

Overall, the paper indicates that the choice of the exchange rate regime has an important impact on economic performance by influencing macroeconomic variables, such as the level of domestic wages, in developing countries. More precisely, the paper finds that the choice of the exchange rate regime matters for developing countries. It provides empirical evidence for a wage premium in fixed relative to floating exchange rate regimes. So far the literature on factor price equalisation has concentrated on real GDP per capita as the principal determinant for differences in factor prices across countries. This paper shows that the exchange rate regime variable can also significantly influence wage levels of countries. Hence, future research could incorporate differences in exchange rate regimes into the explanations for differing factor prices across countries.

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Developing Country Sample			
Algeria	Dominican Republic	Mexico	Surinam
Antigua and Barbuda	Gabon	Myanmar	Thailand
Argentina	Honduras	Nicaragua	Togo
Bolivia	Hungary	Niger	Tunisia
Cameroon	India	Peru	Turkey
Central African Republic	Korea (South)	Philippines	Uruguay
Chile	Latvia	Romania	Venezuela
China	Madagascar	Singapore	Zambia
Costa Rica	Mali	Slovakia	
Czech Republic	Mauritius	Sri Lanka	

Table 1: Country List.

Variables	De Facto Classification				De Jure Classification			
	Mean	StDev	Max	Min	Mean	StDev	Max	Min
Developing Countries:								
Fixed Exchange Rate:								
DWL	0.25	0.13	0.49	0.13	0.21	0.03	0.22	0.17
log(GDP/Capita)	7.02	1.30	8.92	5.43	7.06	1.44	9.09	5.34
Intermediate Regime:								
DWL	0.33	0.33	1.29	0.05	0.29	0.21	0.95	0.05
log(GDP/Capita)	7.58	1.08	9.67	5.64	7.42	1.15	9.78	5.44
Floating Exchange Rate								
DWL	0.30	0.22	0.79	0.06	0.25	0.25	0.75	0.04
log(GDP/Capita)	7.73	1.11	9.82	5.55	7.63	1.19	9.84	5.47

Table 2: Summary Statistics.

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
Exchange Rate Regime	-0.027** (2.063)	-0.037** (2.232)	-0.033* (1.978)	-0.055** (2.590)	-0.09* (1.976)	-0.13* (2.095)
log(GDP/Capita)	0.089*** (3.003)	0.077*** (2.812)	0.083*** (2.861)	0.096 (1.649)	0.071 (1.511)	0.115* (2.002)
Openness	0.002*** (2.702)	0.002*** (3.810)	0.002*** (3.510)	0.002** (2.639)	0.003*** (3.810)	0.002** (2.423)
log(Size)		0.019 (1.014)	0.016 (0.854)		0.019 (1.014)	0.069 (1.173)
Volatility of Money			0.0003* (1.817)			-0.0001** (2.399)
Inflation			0.003 (1.241)			-0.0006 (0.970)
R^2	0.47	0.49	0.52	0.38	0.49	0.60
adj. R^2	0.42	0.43	0.43	0.21	0.43	0.31
SE	0.15	0.15	0.15	0.20	0.16	0.19
Sample Size	38	38	38	15	15	15

Table 3: Regression Results (De Jure Classification): Columns (1)-(3) all countries; (4)-(6) upper middle income economies). *Note: Dependent variable: Domestic Wage Level. Time period 1983-98. t-Statistics in absolute values. *** Significance at the 1, ** at the 5, * at the 10 percent Level.*

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
Exchange Rate Regime	-0.004 (0.612)	-0.005 (0.651)	-0.008 (0.996)	-0.038** (2.127)	-0.045* (1.762)	-0.054* (1.846)
log(GDP/Capita)	0.085** (2.605)	0.082** (2.624)	0.091*** (2.873)	0.123* (1.875)	0.105* (2.029)	0.144* (2.033)
Openness	0.002** (2.458)	0.002*** (3.123)	0.002*** (2.952)	0.0009 (0.712)	0.001 (1.394)	0.0003 (0.203)
log(Size)		0.005 (0.309)	0.004 (0.251)		0.032 (0.791)	0.038 (0.834)
Volatility of Money			0.0004*** (2.645)			-0.0001** (2.278)
Inflation			0.0002 (0.753)			-0.0005 (0.885)
R^2	0.44	0.44	0.50	0.46	0.50	0.59
adj. R^2	0.39	0.37	0.40	0.31	0.30	0.29
SE	0.16	0.15	0.16	0.19	0.19	0.20
Sample Size	38	38	38	15	15	15

Table 4: Regression Results (De Facto Classification): Columns (1)-(3) all countries; (4)-(6) upper middle income economies). *Note: Dependent variable: Domestic Wage Level. Time period 1983-98. t-Statistics in absolute values. *** Significance at the 1, ** at the 5, * at the 10 percent Level.*