Veiled Expectations: The Heterogeneous Impact of Exchange Rate Shocks at the Sectoral-Level

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1 November 2020

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November 2020

Abstract

This paper examines the sectoral-level impact of nominal exchange rate shocks. I introduce a model where agents face bounded abilities to form expectations, and agents' foresight depends directly on the state of financial stress. This leads to differential labour market responses to exchange rate movements. When financial stress is low, absent of shocks, exchange rate movements are minimal and pinned down by agents. When financial stress is salient, agents' foresight is veiled; they fail to form reliable expectations during episodes of sharp depreciation. Workers and firms fail to adjust expected relative wages and future marginal profits respectively, leading to sub-optimal output. Using monthly sectoral data from Malaysia in Simultaneous Equations and Markov-Switching Models, I find heterogeneous labour market responses. In tradable sectors, labour flows were small and concentrated in the manufacturing sector. Likewise, adjustments in non-tradable sectors were small. On the extensive margin, labour market flows diverge between tradable and non-tradable sectors. On the intensive margin, labour market flows in tradable sectors reverse. In contrast, as the model predicts, non-tradable sectors do not react to substantial terms of trade shocks.

Keywords: Exchange Rate, Labour Market Frictions, Financial Stress, Expectations Formation, Regime-Switching, Simultaneous Equations Model

JEL Classification: D84, E44, F31, J20

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1 Introduction

Exchange rate fluctuations have material consequences to economic growth and inflation, making the exchange rate management, or the lack thereof, important monetary policy considerations. The history of exchange rate policy spans three main periods — the Gold Standard, the Bretton Woods and the post-Bretton Woods eras. Each constituted shifts in prevailing policy conventions.

The former two emphasised the elimination of exchange rate risks backed by physical commodities and by international consensus, respectively. The Gold Standard reflected the European and American drives for global trade, against the backdrop of a stable multipolar geopolitical and economic arrangement. The Bretton Woods system, in contrast, reflected an unstable multipolar geo-economic arrangement during the rapid decolonisation exercise, followed by the post-war reconstruction supported by trade. The post-Bretton Woods era coincided with near-complete decolonisation and economic growth miracles in the developing world. In this period, the frequency of exchange rate crises in both emerging and developed economies resembled a cyclical pattern. The global movement towards establishing a free-floating or partially managed exchange rate regime, gave way to the familiar "business cycle" of booms and busts. Real currencies of risky, fast-growing, emerging economies become overvalued. Economic growth generates substantial wealth, financed by large and sustained capital inflows. Subsequently, inflationary pressures build up while leverage becomes less sustainable. Overheating monetary conditions then lead to tighter global monetary policy, especially in safe haven economies illustrated in McCauley and McGuire (2009) [24] and Kohler (2010) [20]. Sudden or gradual stops of capital flows then take form, as investors become more risk averse amidst slowing economic growth. Liquidity fault lines take form, as firms and governments scramble on capital to keep their external balance sheets afloat. Rodrik (2000) [29] further complements the macroeconomic trilemma with the world economic trilemma. Democratic polity and growth convergence necessitate capital controls and limited trade liberalisation, suggesting an international system closer to the Gold Standard and Bretton Woods eras.

Focusing on the impact of nominal exchange rate shocks on the real economy at the subnational level, I submit two arguments. Firstly, financial stress exacerbates the adverse impact on growth consistent with the incremental liberalisation of the international monetary system post-1973. Secondly, industry-level labour market responses are heterogeneous suggesting that further nonlinearities observed by policymakers at various junctions could be due to imperfect inter-sectoral flows.

To guide the discussion, this paper presents a theoretical model that incorporates rationally bounded agents, whose ability to form expectations depends on financial market stress.

In Ding (2018) [11], the probability of agents relying on their central banks for near-term forecasts becomes higher as horizons expand, compensating for their incremental inability to produce reliable expectations. I take this principle to a regime-switching setting. Agents' expectations become explosive during high financial stress periods. Hence, the forecast error of firms and households become infinitely large. Whilst an exchange rate depreciation constitutes a positive productivity shock for the tradable sector, agents find it difficult to pin down the relative attractiveness of varying sectors. Firms do not expand production while workers do not enter the search for jobs in the tradable sectors with higher real wages, leading to suboptimal capital and labour flows. This inability to form reliable expectations opens the possibility for inefficient expenditure-switching, as per Markusen (1986)[23], Mitra and Trindade (2005) [26] and Bems and Giovanni (2016) [3]. In sum, expectation rigidities results in read frictions to labour flows, leading to inefficient resource allocation. The model allows for increasing frictions to labour market flows, a key departure from the prevailing job flows literature, such as in Gourinchas (1999) [14], Mitra and Trindade (2005) [26] and Tille (2006) [33]. For future research, it may be useful to ascertain if central banks find it more difficult to implement monetary policy in a Brainard (1967) [6] manner.

Three empirical strategies were taken. Firstly, a Seemingly Unrelated Regression Equations (SURE) approach was taken to pin down heterogenous industry-level responses. Endogeneity concerns, secondly, motivate a Three-Staged Least Squares (3SLS) estimation. Thirdly, I model the differential responses of tradable and non-tradable sectors under varying latent states to exchange rate depreciation shocks using a Markov-Switching Regime Model.

The remainder of this paper will be structured as follows. Section 2 describes the theoretical model. Section 3 describes the data. Section 4 evaluates the empirical link between financial stress and the incidence of large exchange rate shocks. Section 5 proceeds with the empirical results and discussion. Section 6 concludes.

2 Theoretical Model

2.1 The Global and Domestic Economy

A continuum of $\{i\}_0^\infty$ small open economies produce two tradable goods — manufactured goods $\mathcal{M}$ and commodities $\mathcal{H}$ — and non-tradable products — services $\mathcal{S}$. Within each category of goods, there are a continuum of j differentiable varieties.

$$\{m_j\}_{j=0}^\infty \in \mathcal{M} \tag{1}$$

$$\{h_j\}_{j=0}^{\infty} \in \mathcal{H} \tag{2}$$

$$\{s_j\}_{j=0}^{\infty} \in \mathcal{S} \tag{3}$$

In any economy i, fractions γ_m^i and γ_h^i of manufactured goods and commodities respectively are exported. The remainder are consumed by the residents of country i. All services are consumed by residents as they are non-tradable.

$$\gamma_m^i \in [-1, 1] \tag{4}$$

$$\gamma_h^i \in [-1, 1] \tag{5}$$

$$\gamma_s^i = 0 \forall i \tag{6}$$

$$Y_D^i = 1 - \gamma_m^i M^i + (1 - \gamma_h^i) H^i + S^i \tag{7}$$

$$Y_X^i = \gamma_m^i M^i + \gamma_h^i H^i + S^i \tag{8}$$

$$Y^i = Y_X^i + Y_D^i \tag{9}$$

2.2 Exchange Rate

Furthermore, the exchange rate of an economy contains a forward-looking component and a stochastic component. This provides the motivation for our preferred instrument for the empirical exercise in section 4.

$$\epsilon_t^i = \delta E_t(\epsilon_{t+1}^i) + \mu_t^i \ where \ E_t(\mu_t^i | \epsilon_t^i) \tag{10}$$

Iterating forward gives us the expressions for future exchange rates, for which $T \to \infty$.

$$\epsilon_{t+1}^i = \delta E_{t+1}(\epsilon_{t+2}^i) + \mu_{t+1}^i \tag{11}$$

$$\epsilon^i_{t+2} = \delta E_{t+2}(\epsilon^i_{t+3}) + \mu^i_{t+2} \tag{12}$$

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$$\epsilon^i_{T-1} = \delta E_{T-1}(\epsilon^i_T) + \mu^i_{T-1} \tag{13}$$

By recursive substitution, we obtain the asymptotic expression of exchange rate.

$$\epsilon^i_t = \delta E_t\{\delta E_{t+1}(\epsilon^i_{t+2} + \mu^i_{t+1})\} + \mu^i_t \tag{14}$$

$$\epsilon^i_t = \delta^\infty E_t(\epsilon^i_\infty) \sum_{j=t+1}^{\infty} E_t(\mu^i_j + \mu^i_t) \tag{15}$$

$$\epsilon^i_t = \delta^T E_t(\epsilon^i_T) + \mu^i_t \ for \ T \to \infty \tag{16}$$

By the conditional independence of the stochastic component μ^i_t, second moment of the exchange rate depends on two levers — the size of the forward-looking parameter δ and the variance of μ^i_t.

$$Var(\epsilon^i_t) = \delta^{2T} Var(\epsilon^i_T) + Var(\mu^i_t) \tag{17}$$

We suppose then that the variance of the forward-looking component is fixed, such that the expectations formed are stationary. Equivalently, we consider a conditionally independent case, $Var(\epsilon^i_t) = \sigma^2_\epsilon \ \forall \ t$ and $Var(\mu^i_t) = \sigma^2_\mu \ \forall \ t$, which leads to the following expression.

$$\sigma^2_\epsilon = \frac{\sigma^2_\mu}{1 - \delta^{2T}} \tag{18}$$

It follows then that the variance stationarity of the exchange rate depends entirely on the size of the forward-looking parameter δ. For the rest of the analysis, the assumptions of stationarity and homoskedasticity are dropped to allow for generalisation.

$$\delta < 1 \implies \sigma^2_\epsilon = \sigma^2_\mu \ as \ T \to \infty \tag{19}$$

$$\delta = 1 \implies \sigma^2_\epsilon \to \infty \ as \ T \to \infty \tag{20}$$

Next, we derive the evolution of exchange rates. In the general case, exchange rate dynamics depend mechanically on the forward-looking parameter *delta* and the long-term expected level of exchange rate $E_t(\epsilon^i_T)$.

$$\Delta\epsilon^i_t = \epsilon^i_{t+1} - \epsilon^i_t \tag{21}$$

$$E_t(\Delta\epsilon^i_t) = E_t(\epsilon^i_{t+1}) - \delta E_t(\epsilon^i_{t+1}) - E_t(\mu^i_t) \tag{22}$$

$$E_t(\Delta\epsilon^i_t) = (1-\delta)E_t(\epsilon^i_{t+1}) \tag{23}$$

$$E_t(\Delta\epsilon^i_t) = (1-\delta)\delta^T E_t(\epsilon^i_T) \tag{24}$$

With restrictions on δ, agents in the economy forecast only near-zero movements in the exchange rate. This follows directly from that if the stress conditions are not overwhelming, agents are able to follow anchors provided by markets and policymakers. Hence, they expect the exchange rate to remain stable with plausible minor deviations. All realised, substantial, depreciations ($\Delta\epsilon^i_t < 0$) and appreciations ($\Delta\epsilon^i_t > 0$) must be due to the stochastic component.

$$E_t(\Delta\epsilon^i_t \to 0 \ as \ T \to \infty) \tag{25}$$

However, where $\delta = 1$, we have a special case where agents forecast precisely zero movements in the exchange rate, regardless of the time horizon considered. This provides the key motivation for a regime-switching process linking financial stress with the ability to form reliable expectations. Equivalently, the following equation represents the loss of ability for agents to forecast movements in the exchange rate. As a result, agents resort to backward-looking expectations, where the exchange rate from the current period is carried forward.

$$E_t(\Delta\epsilon^i_t = 0 \ \forall \ T) \tag{26}$$

The real exchange rate follows similar dynamics, scaled only by the relative prices between country i and the rest of the world.

$$\epsilon^i_t = \frac{E^i_t \int_{j=0}^{\infty} \omega^j_t P^j_t dP}{P^i_t} \tag{27}$$

$$\epsilon_t^i = \delta E_t(\frac{E_{t+1}^i \int_{j=0,i\neq j}^{\infty} \omega_{t+1}^j P_{t+1}^j dP}{P_{t+1}^i}) + \mu_t^i \tag{28}$$

2.3 Firms

There is a continuum of forward-looking, risk-neutral household, with constant elasticity of substitution (CES) between goods. The representative household maximises its expected utility over an infinite time horizon.

$$\max\{E[\sum_{t=0}^{\infty} \beta^t C_t]\},\ 0 < \beta < 1 \tag{29}$$

$$C_t = \sum_{\mathcal{W}=\{\mathcal{M},\mathcal{H},\mathcal{S}\}} \alpha_{\mathcal{W}}^{\frac{1}{\phi}} \mathcal{W}_t^{\frac{\phi-1}{\phi}},\ \phi\ U(0,1) \tag{30}$$

$$C_t = \alpha_m^{\frac{1}{\phi}} m_t^{\frac{\phi-1}{\phi}} + \alpha_h^{\frac{1}{\phi}} h_t^{\frac{\phi-1}{\phi}} + (1-\alpha_m-\alpha_h)^{\frac{1}{\phi}} s_t^{\frac{\phi-1}{\phi}},\ \phi\ U(0,1) \tag{31}$$

The elasticities of substitution between goods and between brands of the same class of goods are distributed uniformly. The economy has a continuum of $\{j\}_0^{\infty}$ profit-maximising firms that follow a Cobb-Douglas production function. Firms employ two types of factors of production – capital and labour as denoted by K and L respectively. Producers of manufactured goods, commodities and services differ in input weights at the country-level, which will motivate the degree specialization of each country. Firm-sector-level total factor productivity (TFP) $A_i, \mathcal{W}$ is normally distributed.

$$F(K,L)_{i,j,\mathcal{W}} = A_{j,\mathcal{W}} K_j^{\delta_{i,\mathcal{W}}} L_j^{1-\delta_{i,\mathcal{W}}} \tag{32}$$

$$A_j, \mathcal{W}\ \mathcal{N}(1,\sigma_A^2)\ for\ \mathcal{W} = \{\mathcal{M},\mathcal{H},\mathcal{S}\} \tag{33}$$

$$0 < \delta_{\mathcal{W}} < 1\ and\ \delta_{\mathcal{M}} > \delta_{\mathcal{H}} > \delta_{\mathcal{S}} \tag{34}$$

As such, at the country-level, the specialisation rule is exogenously determined. The fraction of output for goods of type $k \in \mathcal{W}$, η_k, relative to aggregate domestic output, rises as the sectoral productivity increases and the consumer weights, $\alpha_{\mathcal{W}}^{\frac{1}{\phi}}$, increase. As we take consumers' preferences between types of goods as exogenous, $A_{j,\mathcal{W}}$ is the sole determinant of the degree of specialisation.

Production and trade dynamics can be defined under two propositions.

Proposition 1 *Sectoral specialisation is increasing in sectoral productivity, as the relative cost of producing good k becomes lower than that of good j:*

$$\eta_k = f(A_{j,k}; \alpha_{\mathcal{W}}, A_{j,w\neq k}, \phi) \textit{ where } f'(\cdot) > 0 \textit{ and } 0 < \eta_k < 1$$

Proposition 2 *All output that is not consumed by the domestic market are cleared in the world market (follows from the model's construct):*

$$Y^i_{X,\mathcal{W}} = \textstyle\int_0^\infty [F(K,L)_{i,j,\mathcal{W}}]dF - \mathcal{W}_t$$

$$\pi_{i,j,\mathcal{W}} = F(K,L)_{i,j,\mathcal{W}}p - wL_j - rK_j \tag{35}$$

$$w_X = \epsilon A_X(1-\delta_X)(\frac{K}{L})^{\delta_X} \tag{36}$$

$$L = [\frac{\epsilon A_X(1-\delta_X)}{w_X}]^{\frac{1}{\delta_X}} K \tag{37}$$

$$w_D = A_D(1-\delta_D)(\frac{K}{L})^{\delta_D} \tag{38}$$

$$L = [\frac{\epsilon A_D(1-\delta_D)}{w_D}]^{\frac{1}{\delta_D}} K \tag{39}$$

Equation 35 denotes the profit function. Solving for profit maximisation yields equations 36 and 37, and 38 and 39, respectively for export-oriented firms (subscript X) and domestic-oriented firms (subscript D). For simplicity, prices of domestic-bound goods are treated as the numeraire. Hence, the prices of exports is the exchange rate. These follow directly from a Cobb-Douglas production function in a frictionless economy.

$$\pi_{i,j,\mathcal{W}} = F(K,L)_{i,j,\mathcal{W}}p - wL_j - rK_j - (1-\varphi)\psi L_j \tag{40}$$

$$\psi = \gamma\tau\tilde{h}_{\mathcal{W}} \textit{ where } 0 < \gamma < 1 \tag{41}$$

$$wX = \epsilon A_X(1-\delta_X)(\frac{K}{L})^{\delta_X} - (1-\varphi)\gamma\tau\tilde{h}_X \tag{42}$$

$$L = [\frac{\epsilon A_X(1-\delta_X)}{w_X + (1-\varphi)\gamma\tau\tilde{h}_X}]^{\frac{1}{\delta_X}} K \tag{43}$$

$$wD = A_D(1-\delta_D)(\frac{K}{L})^{\delta_D} - (1-\varphi)\gamma\tau\tilde{h}_D \tag{44}$$

$$L = [\frac{A_D(1-\delta_D)}{w_D + (1-\varphi)\gamma\tau\tilde{h}_D}]^{\frac{1}{\delta_D}} K \tag{45}$$

Next, I consider inter-sectoral frictions. Firms face a retraining cost when hiring from other sectors. The profit function, as well as the associated wage setting and employment equations, are reproduced in equations 40 to 45. Whilst retraining recipients may include new entrants in the labour force, I do not explicitly model this aspect to focus on the variation in sectoral labour market flows in response to exchange rate movements. On top of wages and rents, the firm pays a retraining cost ψ per worker. A fraction $1-\varphi$ of workers L_j hired by firm j requires retraining. For simplification, I treat the retraining cost as a linear increasing function of the expected (inverse) human capital $\tilde{h}_{\mathcal{W}}$ related to the firm's sector, scaled by the cost share taken up by the firm, γ. In other words, an export-oriented firm hiring workers transitioning from the domestic-oriented sector spends an amount on training that is inversely proportional to the ex-ante level of skills related to export production.

By explicitly defining γ, we can account for any asymmetry in bargaining power, which influences the share of retraining cost paid. Wages offered, as well as labour employed, decreases as the firm's share of retraining cost increases. For exporters, a depreciation shock increases wages offered, as well as employment, such that it constitutes a positive price shock. Figures 1 and 2 maps the relationship between wages, exchange rate and employment in both cases for exporters, while figures 3 and 4 map that of domestic-oriented firms. The breakeven exchange rate, at all given wage and employment levels, is higher than in the frictionless case.

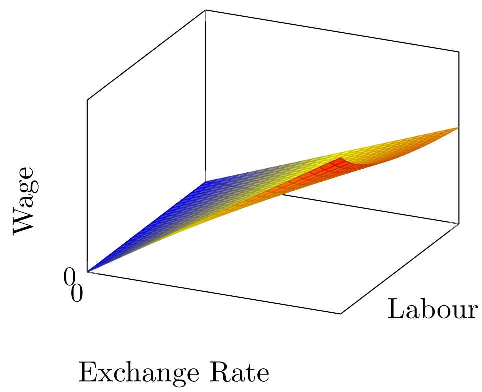

Figure 1: Wage Setting in Export-Oriented Firms (Baseline)

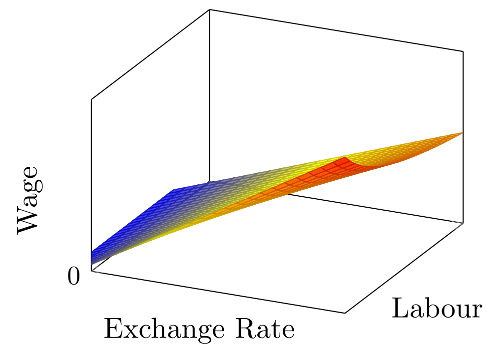

Figure 2: Wage Setting in Export-Oriented Firms (With Frictions)

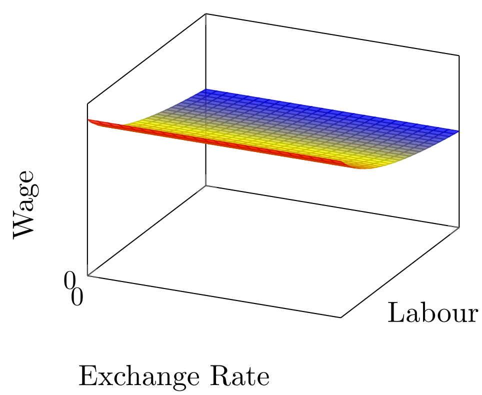

Figure 3: Wage Setting in Domestic-Oriented Firms (Baseline)

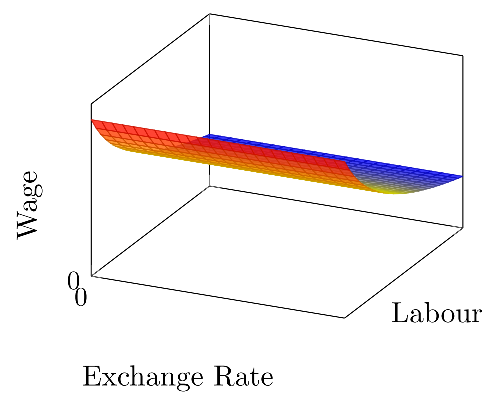

Figure 4: Wage Setting in Domestic-Oriented Firms (With Frictions)

2.4 Households

Workers earn wages w_t and consume c_t in period t. The remainder is saved. Rearranging the intertemporal consumption-savings identity yields expression 50, where contemporary consumption depends directly on expected future wage.

$$c_{t+1} = \frac{1}{\beta}[w_t - c_t] + w_{t+1} \tag{46}$$

$$c_t = w_t + \beta(w_{t+1} - c_{t+1}) \tag{47}$$

$$E_t(c_t) = w_t + \beta E_t(w_{t+1} - c_{t+1}) \tag{48}$$

$$c_t = w_t + \beta E_t(w_{t+1} - c_{t+1}) \tag{49}$$

$$c_t = w_t + E_t[\sum_{k=1}^{\infty} \beta^k (w_{t+k} - c_{t+k})] \tag{50}$$

The model assumes that migration is not possible. Job-search is restricted to the domestic economy. At period t, the representative worker forms expectations about next period's wages across the three sectors in its economy. Suppose that the domestic price is the numeraire, then an exporter pays its worker the marginal revenue product of labour, that is the real exchange rate ϵ_t. Suppose then neither the worker nor the firm know that they may obtain export orders until the end of the period t, the expected wage is weighted average of the marginal revenue product of labour for sector $\mathcal{W}$ across domestic-oriented producers and exporters, accounting for the possibility of job switches.

$$E_t(w_{t+1,\mathcal{W}}) = E_t[\epsilon_{t+1} f'(l_{t+1,\mathcal{W}})^X + (1-\gamma_{\mathcal{W}}) f'(l_{t+1,\mathcal{W}})^D] \tag{51}$$

With CES consumer demand, trade dynamics are entirely governed by Ricardian Comparative Advantage. While beyond the scope of this paper, we may explore the implication of non-homothetic consumer demand, as per Markusen (1986) [23]. The mechanism of propagation into the flows of goods and inputs are elaborated in Mitra and Trindade (2005) [26]. While demand composition shifts when exchange rate moves, as sectoral productivity and real incomes change, the impact on trade is found to be small in Mitra and Trindade (2005) [26].

$$c_t = w_t + \beta_k E_t[\sum_{k=1}^{\infty} (\epsilon_{t+k} f'(l_{t+k,\mathcal{W}})^X + (1-\gamma_{\mathcal{W}}) f'(l_{t+k,\mathcal{W}})^D - \varphi \psi_{t+k,\mathcal{W}_i,\mathcal{W}_j}(h_i, h_j) - c_{t+k})] \tag{52}$$

$$c_t = w_t + \beta_k E_t[\sum_{k=1}^{\infty} (\frac{\epsilon_{t+k} A_{\mathcal{W},X}(\delta_{\mathcal{W},X})}{l_{t+k,\mathcal{W}} \delta_{\mathcal{W},X}} + \frac{1-\gamma_{\mathcal{W}} A_{\mathcal{W},D}(1-\delta_{\mathcal{W},D})}{l_{t+k,\mathcal{W}} \delta_{\mathcal{W},D}}) - \varphi \psi_{t+k,\mathcal{W}_i,\mathcal{W}_j}(h_i, h_j) - c_{t+k}] \tag{53}$$

In equation 53, I consider the ex-ante consumer demand function, expressed in expected wages and the exchange rate, with frictions in the form of retraining cost. Following the earlier discussion on firms' behaviour, workers transitioning between sectors cover fraction ψ of the full retraining cost. Similar to the firm, this is simplified to be inversely proportionate to the level of skills related to the expected inbound sector.

2.5 Expectations Formation

Households, and workers, are rationally bounded. Their ability to accurately forecast wages depends on financial market stress, which then correlates with the exchange rate volatility. The sector-switching rule, as per equations 54 and 55 for cases without and with retraining frictions respectively, from the viewpoint of the worker, is bounded by the variance of exchange rate. If the exchange rate is highly volatile, households have little means to confidently guess the state of future income, of which part may be spent on imported goods. Hence, they remain in their incumbent sector, even if switching is welfare-improving. In other words, κ converges to 0 as exchange rate volatility increases, yielding a multiplicative bias towards staying in the incumbent sector, as outlined in equations 54 and 55.

$$\kappa E_t(w^j_{t+1}) \geq E_t(w^i_{t+1}),\ i \neq j \ where \ i,j \in \mathcal{W} = \{\mathcal{M}, \mathcal{H}, \mathcal{S}\} \tag{54}$$

$$\kappa E_t[w^j_{t+k} - \varphi\psi] \geq E_t[w^i_{t+k}] \tag{55}$$

$$\psi_{i\to i} = 0, \psi_{j\to j} = 0 \tag{56}$$

$$\psi_{i\to j} = \tau_j \tilde{h}_j \tag{57}$$

$$\psi_{j\to i} = \tau_i \tilde{h}_i \tag{58}$$

$$\kappa = f(Var(\epsilon_t)) \ where \ f' < 0, f'' < 0 \ and \ 0 < \kappa < 1 \tag{59}$$

Retraining cost absorbed by the worker are state-dependent. In other words, the identities of the inbound and outbound sectors matter. Should switching be considered, the expected retraining cost is, similar to the firm's problem, inversely related to level of skills related to the inbound sector that is under consideration, as per equations 57 and 58 for workers considering leaving sector i for sector j and vice versa, respectively. Equation 56 clarifies that staying in the incumbent sector incurs no retraining cost. One may consider this friction a simplification of the effort and monetary cost required to learn new skills, relocation to different industrial clusters.

$$\kappa E_t(\pi_{i,t+1}(l'_{t+1})) \geq E_t(\pi_{i,t+1}(l_t)),\ where i \in \mathcal{W} = \{\mathcal{M}, \mathcal{H}, \mathcal{S}\} \tag{60}$$

Likewise, firms cannot pin down output and input prices due to the inability to form reliable exchange rate expectations. Equation 60 defines the reallocation rule for firms, mirroring that of workers. Firms reallocate resources to bundle l'_t from l_t should doing so improve profits. For domestic-oriented firms, κ captures the effect of uncertainty on the value of profits in terms of domestic purchasing power. For export-oriented firms, this uncertainty effect turns multiplicative as exchange rate enters directly the profit equation, hence hiring decisions. Even if the sector faces a productivity shift as a result of terms of trade shocks, the firm maintains its bundle of resources reallocated. To the firm, the decision to stay put amidst elevated exchange rate volatility appears to be optimal. Alternatively, this captures the possibility that risk aversion increases during periods of high exchange rate and financial market volatility[1].

When financial stress approaches infinite looseness, we have the full rational expectations model. The proposed bounded rationality model nests the full rational expectations model. On the opposite end, which is of interest, agents are more likely to stick with their incumbent employment choices despite being Pareto inefficient. In periods of high financial stress, capital outflows and volatile downward exchange rate movements, despite manufacturing yielding higher marginal returns to labour and, hence, real wages, gross job flows are limited. The equilibrium output is therefore not Pareto Efficient, providing us the intuition that countries, especially emerging market economies, have experienced continued downturns despite a sharp depreciation in their real and nominal exchange rates.

$$f(Var(\epsilon_t)) = \frac{\sigma^2}{Var(\epsilon_t)} \tag{61}$$

$$Var(\epsilon_t) = \begin{cases} \sigma^2,\ \mathbf{f}_t \leq \mathbf{f}_t \\ \theta_t \sigma^2,\ \mathbf{f}_t \geq \mathbf{f}_t \end{cases} \tag{62}$$

$$\kappa = \begin{cases} 1,\ \mathbf{f}_t \leq \mathbf{f}_t \\ \frac{1}{\theta_t},\ \mathbf{f}_t \geq \mathbf{f}_t \end{cases} \tag{63}$$

[1]For examples linking risk aversion and asset price volatility, see Shiller (1981) [31], Boyle and Young (1992) [5], Lansing and LeRoy (2014) [22].

$$\theta_t = \frac{\alpha(\mathbf{f}_t - \mathbf{f}_T)}{1 + \alpha(\mathbf{f}_t - \mathbf{f}_T)} \ where \ \alpha < 0, \frac{\partial \theta_t}{\partial \mathbf{f}_t} > 0, \ \frac{\partial^2 \theta_t}{\partial \mathbf{f}_t^2} > 0 \tag{64}$$

$$\kappa = \begin{cases} 1, \ \mathbf{f}_t \leq \mathbf{f}_t \\ 1 + \frac{1}{1+\alpha(\mathbf{f}_t - \mathbf{f}_T)}, \ \mathbf{f}_t \geq \mathbf{f}_t \end{cases} \implies \kappa \to 0 \ when \ (\mathbf{f}_t - \mathbf{f}_T \to \infty) \tag{65}$$

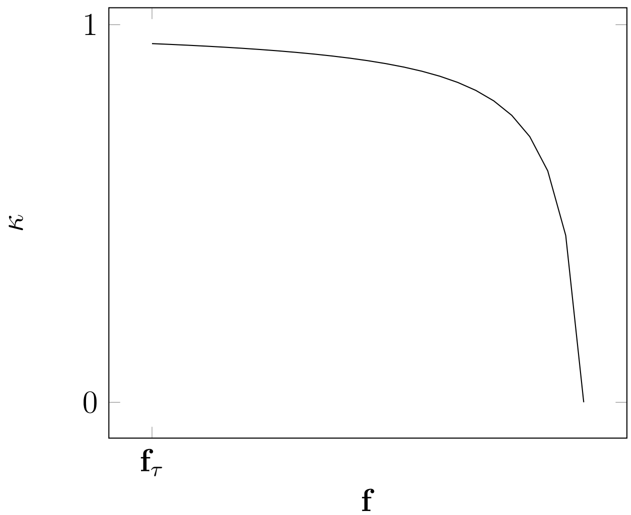

Figure 5: Reliability of Expectations and Financial Stress

I outline the nonlinearity between the expectations reliability and exchange rate volatility in equations 61 through to 65 as a regime switching process, whose state depends on the level of financial stress $\mathbf{f}_t$. Expression 63 follows from combining 61 and 62. When financial stress falls short of the state-switching threshold $\mathbf{f}_T$, agents maintain foresight and form reliable expectations of future wages. Once financial stress exceeds this threshold, the reliability of expectations begin to reduce. Equation 64 posits that the pace of diminishing reliability increases in financial stress. For clarity, I outline a straightforward decreasing concave functional form in equations 64 and 65. As firms and workers live in a state of elevated uncertainty, making useful projections of future profits and wages become increasingly difficult, prompting inaction which yields a visible, clear, income in the incumbent sector. Hence, the parameter κ can be seen as a "veil" to the agents' foresight that becomes more opaque as financial stress explodes. Households, in effect, become blind to any changes in the relative wages.

$$\mathcal{P}_{\mathbf{f}} = \begin{pmatrix} p_{11} & p_{11} \\ p_{21} & p_{22} \end{pmatrix} \tag{66}$$

Leading to empirical estimation, we may treat financial stress as a Markov Mean-Switching Process, as per Davig and Hakkio (2010)[10], with $\mathcal{P}_{\mathbf{f}}$ being the transition matrix between states of "high" and "low financial stress". In the latter, the associated exchange rate regimes has a stationary variance process. Intuitively, households can account for this deterministic variance and produce credible forecasts of future exchange rates, and hence future wages and consumption. In the state of high financial stress, the variance of real exchange rate becomes explosive and non-stationary, motivating the inability of households to produce meaningful forecasts and making job-switching decisions as per rational expectations. In context, these periods are characterised by large exchange rate depreciation, capital outflows, portfolio equity and bond sell-offs, as surveyed by the related currency crisis literature, notably Laeven and Valencia (2010)[21], Reinhart and Rogoff (2009)[28]. In section 4, I explore the relationship between realised exchange rate movements and financial stress.

If we return to our earlier assumption of stationarity and homoscedasticity in the forward-looking component of the exchange rate in section 2.2, we can reduce this mechanism to the forward-looking parameter in the exchange rate state equation. This is nested in the baseline model, where δ can vary.

$$\delta = \begin{cases} k, & \mathbf{f}_t \leq \mathbf{f}_t \\ 1, & f_t \geq \mathbf{f}_t \end{cases} \qquad where\ k < 1 \tag{67}$$

This mechanism motivates using the Simultaneous Equation Models (SEM) and Markov-Switching Model strategies to estimate the impact of exchange rate shocks on gross employment flows. Growth fluctuations during periods of large exchange rate shocks may be due to opaque foresight of agents, leading to frictions in labour market flows.

3 Data

I used sector-level labour and product markets data from Malaysia, collected by the Department of Statistics, Malaysia (DOSM) from the Labour Force Survey (LFS) and the Malaysian Economic Statistics (MES) series. Exports are drawn from the Standard International Trade Classification (SITC), published by DOSM, as part of the MES. Monthly average spot exchange rates of the Malaysian Ringgit (MYR) against the US Dollar (USD)[2], which later motivate our financial stress indicator, are recorded by the Central Bank of Malaysia.

[2]In an earlier version of the paper, I used the trade-weighted nominal effective exchange rate (NEER) and the real effective exchange rate (REER), calculated by the Bank for International Settlements (BIS) at a monthly rate.

I disaggregate the data into five sectors — (i) manufacturing, (ii) mining and quarrying, (iii) agriculture, forestry and fishing, (iv) construction, and (v) services. Exports data are aggregated to match the sectoral classification of the sectors in the LFS. Due to various reclassification exercises by DOSM, the LFS[3] data is restricted to the post-2010 period. Nevertheless, this covers the 2014-15 oil price shock and the 2018 emerging markets currency crises, both accompanied by sharp depreciations in the USD/MYR exchange rate. Monthly data allows us to capture more precise variation in employment flows, financial stress, trade exposure and the nominal exchange rate, compared to annual, albeit longer, data. The sample period avoids the period between 1998 and 2003, where Malaysia's nominal exchange rate was subjected to a peg at MYR3.80/USD. During 2010-18, the MYR depreciated against the USD, on average by 2.82% per month on a year-on-year basis. During 2010-18 in aggregate, the MYR depreciated by 30.985% against the USD, reflecting mainly the effects of the 2014-15 Oil Price Shock and the subsequent tapering of Quantitative Easing (QE) by the Federal Reserve in 2017.

I constructed a binary indicator for large exchange rate shocks, which switches on when the exchange rate depreciates beyond one standard deviation at 8.6% on a year-on-year basis[4]. Entries can be interpreted as an unexpected negative terms of trade shock, where expectations of prices, wages and output need to be readjusted. On average, 14.8% of the period were flagged using this approach, reflecting exchange rate movements during the Oil Price Shock and tapering of QE during 2014-18. Shaping our indicator this way avoids picking up recoveries in the MYR against the USD after the shock episodes, attributable partly to an easing in global financial stress. Laeven and Valencia (2018)[21] and Catao and Milesi-Ferretti (2014)[7] provide comprehensive cross-country definitions of external sector crises, including terms of trade shocks. However, such events are rare in the case of Malaysia. These definitions, therefore, fail to capture episodes of substantial exchange rate movements, such as during the 2015 oil price shock.

All variables except the shock indicator and sectoral export share undergo year-on-year log-differences transformation. This a neat interpretation of coefficients on exchange rates as the estimated marginal propensity of a 1% movement in the exchange rate on sectoral employment growth in percentage points (ppt).

Manufactured goods comprise a sizeable majority of Malaysia's exports, averaging about

[3]Manufacturing contains manufactured goods, miscellaneous manufactured items, chemicals, and machinery and transport equipment. Mining comprises of inedible crude materials, and mineral fuels and lubricants. Agriculture contains animal and vegetable oils and fats, miscellaneous transactions and commodities

[4]For robustness purposes, I have included an indicator for appreciation episodes beyond one standard deviation at 8.6% year-on-year. However, within the sample considered, these episodes are rare and clumped towards the end of sharp depreciation episodes, indicating corrective episodes rather than positive terms of trade shocks. Results remain in line with the main estimation exercise.

67.7% of all exports. Mining and Quarrying goods comprises another 20.7% on average. The Agriculture, Forestry and Fishing sector is mainly a domestic-driven sector, contributing to only 7.89% of all exports on average. Across each year, exports of all three sectors equate the value of headline merchandise exports. I made a simplifying assumption where services and construction are both entirely non-tradable. Export shares of these industries are zero.

As a direct measure of global demand faced by Malaysia at the aggregate level, global GDP growth is estimated as an export-weighted sum of the GDP growth of Malaysia's major trade partners. The decadal (2010-18) average global GDP growth from Malaysia's perspective stood at 4.009%. Furthermore, the export variable contains the aggregate export of goods in the local currency unit, as collected by the Department of Statistics, Malaysia. Exports growth averaged 5.58% between 2010 and 2018.

Employment growth in the mining and quarrying sector average the highest at 5.2%. This is followed by the services, manufacturing and construction sectors, averaging between 2.5% and 4.0%. The agriculture sector's employment growth averaged, by far, the lowest at 0.9%. Within the services sector, employment growth is heterogenous, averaging between -8.8% (Human Health and Social Work) and 9.6% (extraterritorial organisations[5]). The median services subsector average growth was 3.9%, close to the average aggregate growth for the services sector at 4.0%. Aggregating the manufacturing, mining and agriculture sectors together as a wider "tradable" sector, employment growth averaged 2.38%. The "non-tradable" sector, which contains construction and services, stood higher at 3.81%. The estimated second moment of both sectors are relatively similar at 3.23% and 3.05%, respectively. Strictly speaking, employment growth in the tradable sectors is relative more volatile, as compared to non-tradable sectors. This classification is used later in section 5.3 for the Markov Switching Model estimation.

Table 2 contains summary statistics on the financial stress indicators, as well as underlying variables, which will be detailed in section 4. Rows 1 through 4 summarise the underlying indicators in levels. Rows 4 to 8 contain the equity, currency and bonds indices in growth terms, as well as the corresponding financial sector beta. Rows 9 to 11 summarise the headline, HP-filtered and Hamilton (2018)[17]-filtered financial stress indices respectively. The estimation procedure is further detailed in section 4. Note that whilst the financial stress indices were estimated using data from October 1999 through December 2018, table 2 summarises the data only for the time period of interest — January 2010 through December 2018. A complete summary table is presented in appendix A.1.

Returns on equities, on average, expanded by 4.1% on a year-on-year basis. Returns on

[5]Employment in the Extraterritorial Organisations subsector contains 50 missing entries, with multiple breaks in the time series, and is therefore dropped from the analysis.

USD-denominated sovereign bonds edge better at 6.9%. Returns on currencies, on the other hand, performed weaker during the decade, expanding an average of 1.8%. The average financial sector beta, benchmarked to the overall equities returns growth, stood at 1.1 on average, indicating that the volatility in financial sector equities were higher relative to the overall equities market between 2010-18.

Headline financial stress, calculated via Principal Components Analysis (PCA) in section 4, averaged 0.308 standard deviations above its long-term (October 1999 - December 2018) mean. The cyclical component, estimated with the Hodrick Prescott (HP) Filter, averaged a similar, albeit higher 0.358 standard deviation above its long-term mean. The Hamilton (2018)-filtered trend component of financial stress deviates markedly, suggesting that the structural form assumptions of the HP Filter may not hold. Nevertheless, trend financial stress averaged barely 0.09 standard deviations above the long-term mean.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	Mean	S.D.	Min.	Max.
USD/MYR	96	-0.0282	0.0860	-0.293	0.129
Export-Weighted Global GDP Growth	105	4.009	1.598	2.539	9.79
Export	95	0.0558	0.0813	-0.116	0.278
Exchange Rate Shock Indicator	107	0.148	0.357	0	1
Export Share: Manufacturing	107	0.678	0.039	0.595	0.744
Export Share: Mining	107	0.207	0.0322	0.147	0.289
Export Share: Agriculture	107	0.0789	0.0177	0.0468	0.121
Employment: Overall 3mma	92	0.0333	0.0240	-0.00297	0.0874
Employment: Tradable	93	0.0238	0.0323	-0.0765	0.0803
Employment: Non-Tradable	93	0.0381	0.0305	-0.00965	0.113
Employment: Manufacturing	93	0.0331	0.0402	-0.0572	0.125
Export Share: Mining and Quarrying	93	0.0516	0.160	-0.364	0.402
Export Share: Agriculture	93	0.00955	0.0721	-0.199	0.177
Employment: Construction	93	0.0254	0.0693	-0.0881	0.160
Employment: Services:	93	0.0399	0.0280	-0.00464	0.111
Electricity Supply	93	0.0368	0.189	-0.298	0.544
Water Supply	93	0.0392	0.127	-0.190	0.439
WRHR	93	0.0518	0.0345	-0.00960	0.125
Wholesale and Retail Trade	93	0.0413	0.0389	-0.0380	0.125
Accommodation and Food	93	0.0725	0.0561	-0.0319	0.214
TSC	93	0.0335	0.0513	-0.0998	0.166
Transportation and Storage	93	0.0319	0.0582	-0.130	0.167
Information and Communication	93	0.0385	0.0952	-0.269	0.245
FIRB	93	0.0580	0.0567	-0.0589	0.208
Finance and Insurance	93	0.0139	0.0694	-0.140	0.210
Real Estate Services	93	0.0714	0.159	-0.358	0.462
Professional, Scientific and Technical	93	0.0411	0.0907	-0.183	0.235
Administrative and Support	93	0.0958	0.107	-0.0680	0.414
Public Administration and Defence	93	-0.00120	0.0678	-0.142	0.161
Education	93	0.0242	0.0474	-0.0911	0.128
Human Health and Social Work	93	0.0926	0.132	-0.0840	0.437
Arts, Entertainment and Recreation	93	-0.00474	0.169	-0.425	0.313
Households	93	-0.124	0.168	-0.494	0.244
Extraterritorial Organisations	43	-0.0882	1.161	-2.263	2.050
Other Services	93	0.0483	0.0878	-0.162	0.267

Table 1: Summary Statistics — Main

VARIABLES	(1) N	(2) Mean	(3) S.D.	(4) Min.	(5) Max.
MSCI EME Equity Index	108	996.3	103.3	740.3	1,255
MSCI EME Currency Index	108	1,599	68.99	1,437	1,726
MSCI EME Financial Sector Equity Index	108	332.7	35.97	240.1	422.9
FTSE Russell USD Sovereign Bonds Index	108	676.2	97.06	478.9	828.6
Equity Index Growth	108	0.0409	0.179	-0.291	0.628
Currency Index Growth	108	0.0182	0.0635	-0.132	0.186
Financial Sector Beta	108	1.113	0.201	0.657	1.721
USD Sovereign Bond Returns Growth	108	0.0686	0.0718	-0.0642	0.262
Financial Stress Index	108	0.308	0.791	-2.173	1.869
Financial Stress Index (HP Filter)	108	0.357	0.396	-0.359	0.903
Financial Stress Index (Hamilton)	108	0.0885	0.171	-0.409	0.524

Table 2: Summary Statistics — Financial Stress

4 Financial Stress and Exchange Rate Shocks

Section 2.5 posits that once financial stress crosses threshold $\mathbf{f}_T$, the ability of agents to produce reliable expectations diminish, leading to inefficient allocation of resources. Tradable and non-tradable sectors behave differentially under high financial stress, both extensively and intensively relative to when financial stress is low. However, the choice of reduced form estimation later in section 5.3 requires that regime switches in exchange rate movements can be explained by that of financial stress.

To this end, we need an indicator for financial stress observed by agents in a small open emerging market economy. I constructed a simple financial stress indicator for emerging market economies (EME) [6] [7]. As input variables, I used indices[8] covering equity prices,

[6] Numerous examples on the construction of financial stress indicators using Principal Components Analysis (PCA) exist in the literature. Readers may, for instance, refer to Aramonte et al (2017)[2] for a summary of the estimation methodology as well as an assessment on the properties of financial stress indices that are widely used.

[7] Firstly, I standardised the four input variables. Secondly, the components of the first eigenvector was extracted to be used as weights for the respective input variables. Thirdly, a weighted sum of the standardised input variables was calculated. Finally, the weighted sum was multiplied by -1 and standardised, giving us the financial stress indicator.

[8] The indices used directly were the MSCI Emerging Markets Equity Index, the MSCI Emerging Markets Currency Index and the FTSE Emerging Markets US Dollar Government Bond Index.

USD-denominated sovereign bond returns and currency returns, as well as the beta[9] of financial sector equity prices benchmarked to headline equity prices. Weights assigned to each input variable are the eigenvector entries of the first principal component, estimated by implementing a Principal Components Analysis (PCA) on all four variables.

Formally, suppose that financial stress $\mathbf{f}$ is a linear combination of the four input variables $\mathbf{X}$, weighted by the respective entries in the weighting matrix $\mathbf{w}$. In other words, $\mathbf{f}$ is the score of the principal component that comprises the largest proportion of variance in $\mathbf{X}$.

$$\mathbf{f} = \mathbf{w}\mathbf{X} \tag{68}$$

Next, note that a financial stress indicator should show the magnitude of tightness or looseness in financial conditions relative to its long-term average neatly. Taking the score $\mathbf{f}$ directly does not provide a direct interpretation. As such, I standardise $\mathbf{f}$ to obtain $\mathbf{F}$. $\mathbf{F}$ indicates the extent in which financial stress is above or below the long-term average in standard deviations.

$$\mathbf{F} = (\mathbf{f} - \bar{\mathbf{f}})\hat{\sigma_{\mathbf{f}}}^{-1}\mathbf{I} \tag{69}$$

To isolate cyclical fluctuations likely due to exogenous stochastic shocks from the deterministic component observed by agents, I further decompose the indicator into cyclical and trend components using a Hodrick-Prescott (HP) Filter[10]. I estimate $\mathbf{h}$, the estimated trend component of financial stress $\mathbf{F}$.

$$\min_{\{h\}_{t=1}^{T}} \{\sum_{t=3}^{T}(f_t - h_t)^2 + \delta \sum_{t=3}^{T}[(f_t - h_{t-1}) - (f_{t-1} - h_{t-2})]^2\} \tag{70}$$

The HP-filtered financial stress indicator should be interpreted with great reservation, as argued by Hamilton (2018)[17]. For robustness, I include the headline indicator. Fitted values $\hat{\mathbf{F}}$ from a regression of 24-month ahead $\mathbf{F}$ whose coefficients are the ordinary least

[9]This is calculated using the MSCI Emerging Markets Financials Index and the MSCI Emerging Markets Equity Index. In particular, this refers to the one-year beta of equities in the financial sector. For entry in period t, I calculated the ratio between the covariance of the two indices and the variance of the equity index, covering t through $t-12$: $\beta = \frac{Cov(EMEquity, EMFinancials)}{Var(EMEquity)}$

[10]The smoothing parameter of the HP Filter is set to $\delta = 4800$, following Ravn and Uhlig (2002)[27].

squares (OLS) estimates[11] are included.

$$\mathbf{F}_{t+24} = \sum_{k=1}^{12} \gamma_k \mathbf{F}_{t-k} + \epsilon_t \tag{71}$$

$$\widehat{\mathbf{F}_{t+24}} = \sum_{k=1}^{12} \hat{\gamma_k} \mathbf{F}_{t-k} \tag{72}$$

$$\hat{\gamma_k} = (\mathbf{F}'_{t-k}\mathbf{F}_{t-k})^{-1}\mathbf{F}'_{t-k}\mathbf{F}_{t+24} \tag{73}$$

The reason for an EME indicator rather than a Malaysia-specific indicator is of two-fold. Firstly, to ensure consistency in the estimates, we require the explanatory variable, i.e. financial stress, to be uncorrelated with the errors in exchange rate movements. Malaysia contributes approximately 1.6% of the indices used to construct the indicator. This provides assurance that country-specific developments in Malaysia are unlikely to influence the movements in the headline EME financial stress indicator. Secondly, Malaysia is part of the wider universe of EME. Portfolio adjustments and carry trade by international investors are expected to be benchmarked against the overall state of financial markets in the EME universe. A Malaysia-specific indicator may not necessarily capture these shifts in relative pricing of risks.

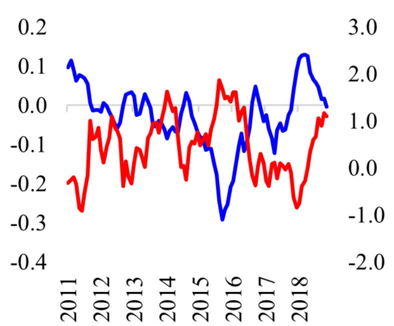

Figure 6: Financial Stress (Red) and USD/MYR (Blue)

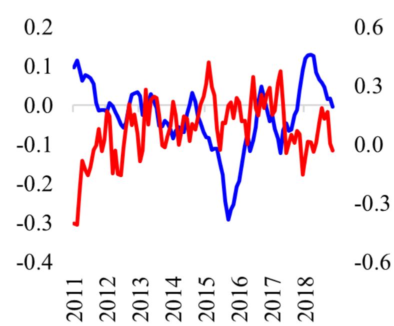

Figure 7: Hamilton (2018)-Filtered Trend (Red) and USD/MYR (Blue)

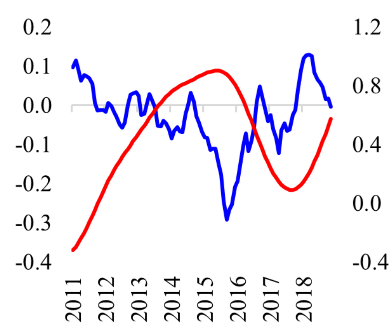

Figure 8: HP-Filtered Trend (Red) and USD/MYR (Blue)

Equations 54 to 65 in section 2.5 suggest that the degree of financial stress directly affects the formation of reliable expectations. However, I argued in Section 2.2 that the realisation of

[11] For cases with quarterly data where the primary interest is of business cycle fluctuations, Hamilton (2018) [17] suggests regressing a variable 8-quarters ahead on the four most recent values as of period t. As our financial stress indicator is available monthly, our choices of variables will be 24-month ahead and 12-month lags respectively.

large exchange rate fluctuations are likely due to exogenous factors. This, in part, motivated the choice of instrument in Section 5.2, a dummy variable for large exchange rate movements rather than the financial stress indicator here. To illustrate this argument, I estimate the probabilities of an exchange rate shock via MLE, using the logit link function.

$$Pr(shock_t = 1|X_t) = \frac{exp(\mathbf{X}_t'\beta + \epsilon_t)}{1 + exp(\mathbf{X}_t'\beta} \tag{74}$$

I perform variable and lag selection for $\mathbf{X}_t$ using the LASSO, due to Tibshirani (1996)[32], as per section 5.1. The use of LASSO in this case is a purely predictive exercise, with no cases made for claims of causality or any structural channels. For both headline financial stress, HP-filtered trend and Hamilton (2018)[17]-filtered trend, I initialised the estimation with 12-months of lags of financial stress, as well as contemporaneous financial stress in order to allow the selection algorithm to consider possible seasonality within a year.

Equation 75 details the LASSO, with the explanatory variable being the exchange rate shock dummy. The shrinkage parameter λ is selected via the rolling cross-validation procedure as per Hyndman and Athanasopoulos (2018)[18].

$$\min\{\frac{1}{2}\sum_{t=1}^{T}(shock_h - \alpha - \sum_{h=1}^{H}\sum_{k=1}^{K}\mathbf{X}_{kh}\beta_{kh})^2 + \lambda\sum_{h=1}^{H}\sum_{k=1}^{K}|\beta_{kh}|\},\ \lambda > 0 \tag{75}$$

$$\lambda \equiv min\{\frac{\sum_{t=h}^{T-1}(\hat{y}_{t+1}^{(t)} - \hat{y}_{t+1})^2}{T-h-1}\} \tag{76}$$

Table 3 summarises the logit estimates using the lags selected by the LASSO algorithm. Importantly, column 1 suggests that headline financial stress has no predictive power for the incidence of any exchange rate shocks, with none of the variables selected. Columns 2-3, however, suggest the opposite for trend financial stress. Figure 9 maps the fitted probabilities of exchange rate shocks for each of the specification. For both the HP-filtered and Hamilton (2018)[17]-filtered trend of financial stress, periods of distinctively higher fitted probabilities appear to overlap with periods where actual shocks occurred.

VARIABLES	(1) Headline	(2) Hamilton (2018)	(3) HP Filter
Contemporaneous	-	7.599**	25.60
		(3.522)	(16.88)
1-month lag	-	-	-
2-month lag	-	1.347	-
		(3.860)	
3-month lag	-	3.895	-26.45
		(4.754)	(21.51)
4-month lag	-	3.798	-
		(4.320)	
5-month lag	-	6.252*	-
		(3.713)	
6-month lag	-	-	-
7-month lag	-	6.751**	-
		(3.254)	
8-month lag	-	-	-
9-month lag	-	-	-
10-month lag	-	6.496	-
		(4.093)	
11-month lag	-	2.524	-
		(5.493)	
12-month lag	-	-0.635	30.68**
		(4.455)	(15.43)
Constant	-1.749***	-7.228***	-23.19
	(0.272)	(1.364)	(14.28)
Observations	108	96	96

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Logit Estimates

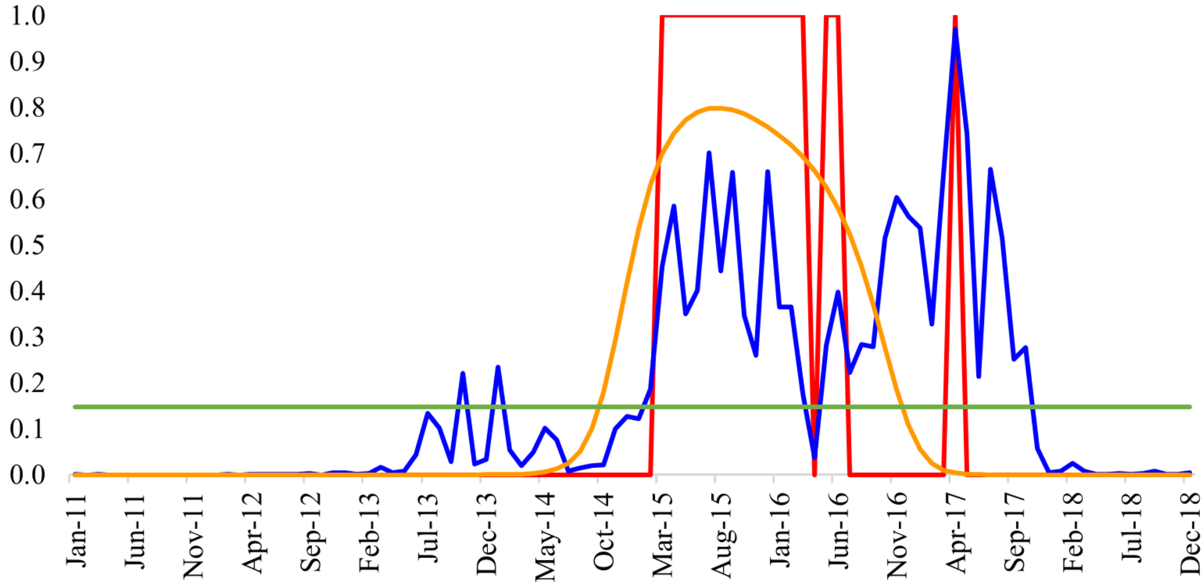

Figure 9: Fitted Probabilities
Red: Shock Dummy; Blue: Hamilton (2018) Filter; Orange: HP Filter; Green: Headline

Financial stress, absent of cyclical disturbances, may predict exchange rate shocks. The results, qualitatively, agree with that periods of high financial stress and large exchange rate depreciation are not distinct. However, I make no claim that financial stress may be a sufficient statistic of exchange rate fluctuations. Whilst financial stress affects asset price volatility, credit easiness, as well as intertemporal investment and consumption decisions, which influence expectations, the direct price and income effects of exchange rate shocks remain central to this paper's model and empirical goal.

5 Empirical Results

5.1 Baseline Simultaneous Equation Model

I estimate the following system of Seemingly of Unrelated Regression Equations (SURE), allowing for cross-sectoral autocorrelation in the errors.

$$y_{1t} = \epsilon_{1t}\beta_1 + \mathbf{X}_{1t}\gamma_1 + \eta_{1t} \tag{77}$$

$$\vdots$$

$$y_{St} = \epsilon_{St}\beta_S + \mathbf{X}_{St}\gamma_S + \eta_{St} \tag{78}$$

$$E(\eta_{st}|\epsilon_{st}) = 0 \tag{79}$$

$\mathbf{Y}_{st}$ contains gross employment flows for sector s, ϵ_{st} the spot exchange rate, $\mathbf{X}_{st}$ a vector of sector-level export share, export-weighted global GDP growth and cross-sectional three-month moving average of gross employment, while η_{st} contains the errors. Interaction terms between the exchange rate, export-weighted GDP, as a proxy for fluctuations in global demand for Malaysia's exported products, and sectoral export share are also included in $\mathbf{X}_{st}$. To consistently estimate β, the exchange rate elasticities of sectoral employment, sequential exogeneity must hold. Given logarithmic difference transformation, the equivalent condition is as above in equation 79.

As SURE allows for cross-equation correlation in the error terms, the error matrix η will not be diagonal. Hence, β and γ, vectors containing the coefficients for the exchange rate variable and other controls respectively, should be estimated by Feasible Generalised Least Squares (FGLS). ω_1 and ω_2 are the weighting matrices for the respective estimators, $\hat{\beta}$ and $\hat{\gamma}$.

$$\hat{\beta} = (\epsilon' \omega_{\mathbf{1}} \epsilon)^{-1} (\epsilon' \omega_{\mathbf{1}} \epsilon) \tag{80}$$

$$\hat{\gamma} = (\mathbf{X}' \omega_{\mathbf{2}} \mathbf{X})^{-1} (\mathbf{X}' \omega_{\mathbf{2}} \mathbf{X}) \tag{81}$$

Baseline results are in table 4. I further control for export share and export-weighted global GDP growth in table 5. This attempts to partial out variation in employment due to shifts in export exposure and fluctuations in global demand, motivated by two reasons. Firstly, as wage is a function of price and output, movements on the relative physical size of the export sector may separately impact expected wages and employment. Secondly, in a small open economy, movements in external demand present an exogenous volume shock. However, the core component of exchange rate should respond to external volume shocks. Row 1 of columns 1 to 5 contain estimates of the sector-level exchange rate elasticities of employment. Standard errors are adjusted for small-samples.

Next, I include interaction terms between export share, the exchange rate and the export-weighted global GDP growth. The marginal propensity of exchange rate movements on employment share may be nonlinear, such that it is dependent on both trade exposure, as well as the cyclical swings in external demand. Moreover, the impact of global GDP growth on employment growth in export-oriented industries may similarly depend on sectoral export exposure, as well as the variability in the price equation, due in part to the exchange rate.

Suppose that the relationships here are linear in parameters, albeit nonlinear in marginal propensity, then controlling for interaction terms may resolve possible omitted variable biases faced in tables 4-5. Results are reported in table 6.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Manufacturing	Mining	Agriculture	Construction	Services
USD/MYR	-0.0108	-0.617***	0.0324	-0.0578	0.0132
	(0.0432)	(0.144)	(0.0903)	(0.0596)	(0.0152)
Overall 3mma	0.781***	3.846***	0.151	1.976***	1.006***
	(0.151)	(0.505)	(0.316)	(0.209)	(0.0532)
Constant	0.00531	-0.103***	0.00546	-0.0450***	0.00564**
	(0.00640)	(0.0214)	(0.0134)	(0.00883)	(0.00225)
Observations	91	91	91	91	91
R-squared	0.227	0.454	0.004	0.498	0.798

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: SURE Estimates (Baseline)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Manufacturing	Mining	Agriculture	Construction	Services
USD/MYR	0.00617	-0.658***	-0.127	-0.0400	0.0184
	(0.0496)	(0.165)	(0.0971)	(0.0685)	(0.0175)
Export Share	0.0800	-0.612	-0.141		
	(0.0807)	(0.403)	(0.327)		
Export-Weighted Global GDP	-0.00483	0.0230	0.0630***	-0.00682	-0.00199
	(0.00947)	(0.0321)	(0.0182)	(0.0130)	(0.00330)
Overall 3mma	0.889***	4.050***	-0.265	2.026***	1.020***
	(0.178)	(0.586)	(0.342)	(0.229)	(0.0585)
Constant	-0.0353	-0.0632	-0.192***	-0.0226	0.0122
	(0.0686)	(0.117)	(0.0646)	(0.0435)	(0.0111)
Observations	91	91	91	91	91
R-squared	0.229	0.457	0.105	0.500	0.798

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: SURE Estimates (Controls)

VARIABLES	(1) Manufacturing	(2) Mining	(3) Agriculture	(4) Construction	(5) Services
USD/MYR	-11.95**	5.888	0.175	-2.141***	0.196*
	(5.944)	(7.351)	(3.065)	(0.359)	(0.106)
Export Share	0.683	2.946	4.486*		
	(0.608)	(2.899)	(2.581)		
Export-Weighted Global GDP	0.102	0.190	0.160***	0.00804	-0.00325
	(0.114)	(0.167)	(0.0599)	(0.0113)	(0.00334)
USD/MYR*Export Share	17.45**	-33.35	7.011		
	(8.478)	(38.03)	(45.14)		
USD/MYR* Export-Weighted Global GDP	3.623**	-2.976	-0.219	0.646***	-0.0545*
	(1.659)	(2.160)	(0.836)	(0.109)	(0.0322)
Export Share* Export-Weighted Global GDP	-0.161	-0.824	-1.306*		
	(0.168)	(0.805)	(0.719)		
USD/MYR* Export Share*Export-Weighted Global GDP	-5.290**	15.22	-0.400		
	(2.374)	(11.06)	(12.19)		
Overall 3mma	0.915***	4.161***	-0.226	1.990***	1.023***
	(0.178)	(0.572)	(0.329)	(0.195)	(0.0576)
Constant	-0.436	-0.778	-0.533**	-0.0804**	0.0171
	(0.414)	(0.595)	(0.213)	(0.0382)	(0.0113)
Observations	91	91	91	91	91
R-squared	0.270	0.522	0.182	0.639	0.805

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: SURE Estimates (Interaction)

Marginal propensities of exchange rate to employment for the respective sectors, with respect to export share and global GDP growth, are displayed in figures 10 to 14. Given an average export exposure and export-weighted global GDP of 67.7% and 4.01%, respectively, manufacturing employment is expected to moderate by 0.03ppt in response to a 1% depreciation in the exchange rate. SURE results contradict economic intuition that an export-oriented sector should expand when the exchange rate depreciates, such that prices of exports priced in a foreign currency, e.g. the USD, turns cheaper. Endogeneity between employment flows and the exchange rate may drive biases embedded in the results above. Employment fluctuations in export-oriented sectors in small open economies, such as Malaysia, may impact the pricing of risks in financial markets, hence directly influencing capital flows and finally the exchange rate.

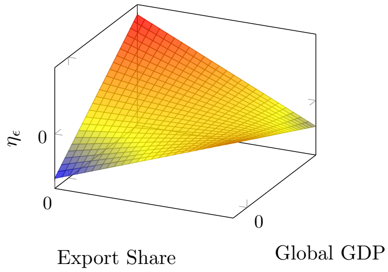

Figure 10: Manufacturing

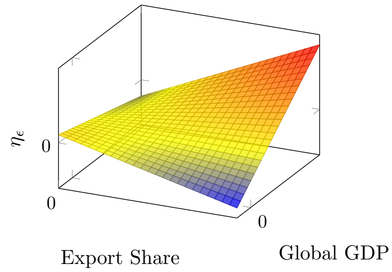

Figure 11: Mining

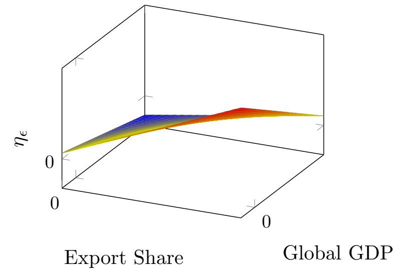

Figure 12: Agriculture

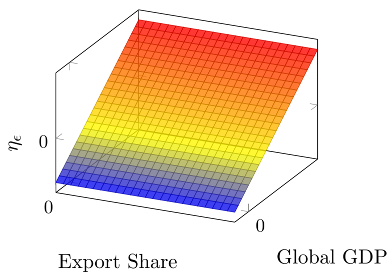

Figure 13: Construction

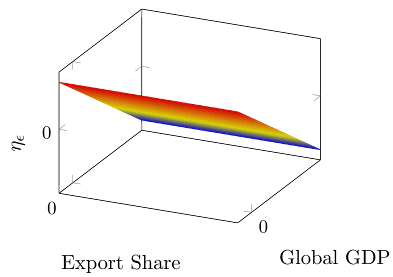

Figure 14: Services

5.2 System Instrumental Variables

Using exchange rate movements as an explanatory variable suffers from endogeneity concerns. Without pinning down the partialled-out response of manufacturing employment to exchange rate fluctuations, little light on the underlying mechanism that can be shed. This concern motivates an instrumental variables strategy. Here, I estimate a 3-Stage Least Squares (3SLS) Model.

$$\mathbf{y}_t = \epsilon_t \beta + \mathbf{X}_t \gamma + \eta_t \tag{82}$$

$$\epsilon_t = \mathbf{Z}_t \gamma + \mathbf{X}_t \delta + \omega_t \tag{83}$$

$$E(\mathbf{Z}_t' \eta_t) = 0 \tag{84}$$

$$E(\mathbf{Z}_t' \epsilon_t) \neq 0 \tag{85}$$

Following Zellner and Theil (1962)[36] and Wickens (1969)[35], consistency in the 3SLS coefficient estimates require two conditions, which are closely related to their 2SLS counterpart.

Firstly, the exclusion restriction must hold. Our choice of excluded instruments cannot be correlated with the unexplained variation in all of the sectors' employment growth. Secondly, the rank condition, or instrumental relevance, must be satisfied. The excluded instruments must be correlated with the endogenous variable, exchange rate.

I estimated β using a staged-based approach, extending the 2SLS IV estimator, as described in Zellner and Theil (1962)[36].

$$\hat{\beta} = (\mathbf{Z}'\omega_3\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Z})^{-1}\mathbf{Z}'\omega_3\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{y} \tag{86}$$

$$\hat{\beta} = (\mathbf{Z}'\omega_3\mathbf{Z})^{-1}\mathbf{Z}'\omega_3\mathbf{y} \tag{87}$$

This economic behavior of small open economy motivates a neat set of possible instrumental variables. Firstly, small open economies do not have sufficient market power in the pricing of financial market risks, with capital flows subject to global shocks that countries like Malaysia do not have direct control over. Secondly, exchange rates respond to global portfolio capital flows to and from the country. Fund managers do not decide portfolio flows based on exchange rate movements. Whilst the direction of causality is likely to be two-way, large systemic global shocks, such as the 2014-15 Oil Price Shock, are likely exogenous to both fund managers' expectations, realised capital flows and policymakers' actions. Therefore, our preferred choice of instrument is the dummy variable for large fluctuations in the nominal exchange rate. As interaction terms between export share, export-weighted global GDP growth and the exchange rate also enter the equation, interaction terms between export share, export-weighted global GDP growth and the shock dummy enter the first stage estimation as excluded instruments.

VARIABLES	(1) Manufacturing	(2) Mining	(3) Agriculture	(4) Construction	(5) Services
USD/MYR	-10.36	2.285	-1.507	-1.339***	-0.149
	(7.413)	(9.145)	(5.687)	(0.508)	(0.155)
Export Share	0.899	3.398	1.826		
	(0.682)	(3.070)	(4.732)		
Export-Weighted Global GDP	0.128	0.250	0.0960	0.0168	-0.00504
	(0.129)	(0.182)	(0.113)	(0.0129)	(0.00393)
USD/MYR* Export Share	15.29	-10.11	57.47		
	(10.64)	(46.65)	(86.17)		
USD/MYR* Export-Weighted Global GDP	2.852	-1.851	0.153	0.348**	0.0664
	(2.137)	(2.825)	(1.783)	(0.164)	(0.0499)
Export Share*Export-Weighted Global GDP	-0.197	-1.024	-0.516		
	(0.190)	(0.861)	(1.434)		
USD/MYR* Export Share*Export-Weighted Global GDP	-4.231	7.610	-14.08		
	(3.084)	(14.34)	(26.69)		
Overall 3mma	0.966***	4.039***	-0.283	1.897***	1.049***
	(0.187)	(0.598)	(0.379)	(0.214)	(0.0651)
Constant	-0.589	-0.934	-0.311	-0.109**	0.0226*
	(0.463)	(0.641)	(0.371)	(0.0438)	(0.0133)
Observations	91	91	91	91	91
R-squared	0.242	0.495	0.075	0.577	0.757

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: 3SLS Estimates

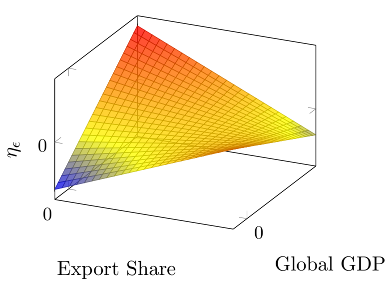

Figure 15: Manufacturing

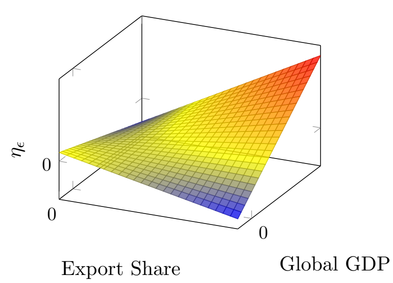

Figure 16: Mining

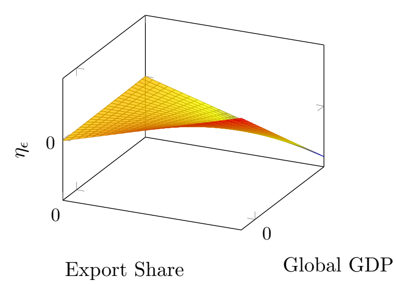

Figure 17: Agriculture

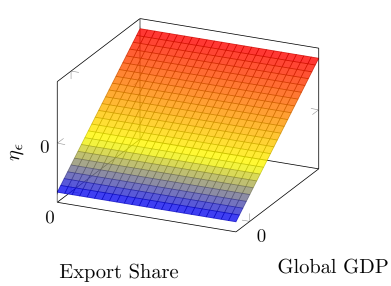

Figure 18: Construction

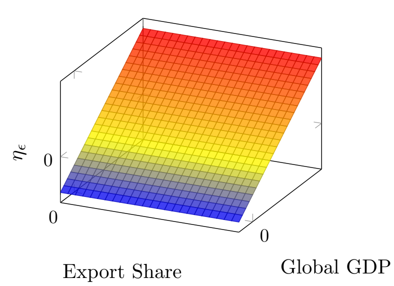

Figure 19: Services

Table 7 contains the results from the 3SLS estimation. Figures 15 to 19 map the marginal propensities of exchange rate movements to employment in the respective sectors, with respect to export share and global GDP growth. Figure 15 suggests that the elasticity of employment in the manufacturing sector to the exchange rate is nonlinear. In two instances, employment moderates, as hypothesised, when the exchange rate appreciates. The furst occurs when global GDP growth is low and when the sector is largely domestic-oriented (lower left corner). The second occurs when manufacturing comprises most of the economy's exports and when the export-weighted global GDP growth is high (upper right corner). As external demand is strong, a depreciation in the exchange rate constitutes a positive price effect, resulting in greater demand for manufactured exports, hence an expansion in the sector. In contrast, the case where specialisation is high but external demand is weak (lower right corner) yields the opposite — a depreciation leads to a moderation in employment. Cheaper export prices in foreign currency terms simply fails to capture further external demand, which exhibits weakness in such cases, leading to negative dividends from a depreciation.

Across columns 1-3, to the extent that exchange rate shocks are stochastic and that exchange rate movements are ordered before gross employment flows, the impact of export share variation and global demand on gross employment flows on all three tradable sectors is unlikely to be different from zero. The marginal propensity of exchange rate movements on employment in all three tradable sectors exhibit nonlinearities, with respect to external demand and the degree of specialisation, as illustrated for the manufacturing sector earlier.

The mining sector juxtaposes the manufacturing sector. The exchange rate elasticity of employment turns positive when the economy is fully specialised in mining and when global GDP growth is near-zero, as well as when mining is fully domestic-oriented and when global GDP growth peaks. In contrast to the manufacturing sector, the impact of a depreciation on employment is positive in two instances. Firstly, this occurs when global GDP growth is low and when the economy is fully specialised in mining. The second occurs when global GDP growth is high and when mining is fully domestic-oriented. Employment in the agriculture sector expands in response to an exchange rate depreciation only in one instance – when global GDP growth is high and when exports comprise almost entirely of agricultural products (upper right corner). In both non-tradable sectors, the 3SLS estimates suggest that employment accelerates in response to an exchange rate depreciation when global GDP growth is low.

Next, I evaluate the sectoral marginal propensities given the decadal average global GDP growth and export share. In column 1, suppose a manufacturing export share of 67.7%, as per the decadal average, the estimated marginal propensity of employment implies an 8.26ppt acceleration in response to a 1% depreciation. Given the average export share of 20.7% in the mining sector, the expected response is a small 0.9ppt acceleration in employment. A stronger USD may result in a positive wealth effect in parts of the industry that produces commodities priced in USD e.g. crude oil, leading to stronger expansion. However, the lower export exposure, as well as negative wealth effects experienced by subsectors whose goods are priced in MYR e.g. liquefied natural gas products may offset positive gains elsewhere. In the agriculture sector, the expected response, given an export share of 7.89%, is a 0.81ppt acceleration. However, as iterated, conditional on the model being correctly specified in the null, the responses of the mining and agriculture sectors, separately, are unlikely to be different from zero. Taken together, labour market adjustments are likely absent in the tradable industry, albeit concentrated in the manufacturing sector.

In column 5, the implied elasticity suggests an imprecisely estimated 0.1ppt moderation in response to a 1% depreciation in the MYR against the USD. The autarkic services sector experiences neither immediate productivity gains nor losses as the exchange rate moves. Nevertheless, expected real wages in the sector diminish as every domestic unit of wage received can be used to less units of consumer goods, due to imported goods becoming more expensive in the domestic currency. In column 4, the coefficient on exchange rate for the construction sector is precisely estimated and negative, where the associated employment growth response to a 1% appreciation in the MYR is a 0.44ppt acceleration, conditional on global GDP growth at the decadal average.

While quantitatively inconclusive, the behavior of the Malaysian economy may be at odds with theoretical predictions. From section 2, when the exchange rate depreciates, real incomes in domestic-driven sectors, such as construction and services, are expected to fall. To a lesser extent, this should include the agriculture sector. This behavior is observed only in the construction sector, under the established model assumptions. Subsequently, a fall in expected wages should drive workers to leave their sectors and move into the exports-driven manufacturing sector. From the firms' perspective, we draw from Melitz (2003)[25]. Firms that are no longer viable shut down, subsequently diverting their resources to more exports-driven firms. Drawing from Gourinchas (1999)[14], Goldberg and Tracy (2001)[13] and Tille (2006)[33], output stabilises during periods of depreciation as labour flows to the tradable sector — mainly the manufacturing sector in this context. This posited flow mechanism is largely absent, from both a mechanical and expectation-driven perspectives suggested in section 2. My theoretical model provides an agent-based justification for the absence of these aggregate labour market flows. Agents are unable to form accurate expectations of their income should they move away from the now less productive non-tradable sector. As such, the expansion in the tradable sector is suboptimal. The response of national income in an export-oriented economy then tilts towards a moderation, rather than an expansion. Going forward, I question if agents within the tradable sector respond differentially to exchange rate movements, under varying states.

5.3 Markov-Switching Model

I attempt to quantify the characteristics of the expectations channel proposed in Section 2.5. I estimate a two-state multivariate Markov-Switching Model, due to Hamilton (1989)[15] and Hamilton (1990)[16], to gauge plausible presence of within-sector exchange rate state switches. For a neater discussion, I aggregate the five sectors into two groups — (i) tradable and (ii) non-tradable sectors. The former consists of the manufacturing, agriculture and mining sectors, while the latter consists of the construction and services sectors. Two considerations motivate this aggregation. Firstly, earlier results suggested possible frictions to flows for all three tradable sectors, rather than only in select ones. Secondly, the theoretical model in section 2 points to aggregate adjustments in the tradable sector. With a two-sector aggregation, evaluation of differential employment flows under varying regimes can be made directly.

Suppose that exchange rate contains forward-looking and stochastic components, as outlined in section 2.2. Reproducing results for the generalised case, the second moment of contemporaneous exchange rate, like the realised exchange rate, depends on the variance of future exchange rates and that of the stochastic shock component. Without further assumptions on expectations formation, we cannot rule out the possibility that large fluctuations may also stem from the forward-looking component.

$$\epsilon_t^i = \delta E_t(\epsilon_{t+1}^i) + \mu_t^i \tag{88}$$

$$Var(\epsilon_t^i) = \delta^{2T} Var(\epsilon_T^i) + Var(\mu_t^i) \; for \; T \to \infty \tag{89}$$

To justify this empirical approach, at least one of two propositions must happen. The first follows the stationary and homoscedastic case. Under the generalised case, the second forces large fluctuations to come from the stochastic component of the exchange rate process. In other words, any "large" movements are due to unexpected shocks, rather than from the agents' forecasts of exchanges rates within their horizon of expectations.

Proposition 3 $Var(\epsilon_t^i = \sigma_\epsilon^2) \; \forall \; t \; and \; Var(\mu_t^i) = \sigma_\mu^2 \; \forall \; t$

Proposition 4 $\delta < 1 \; when \; \mathbf{f}_t \leq \mathbf{f}_T$

As the Markov-Switching Model requires Maximum Likelihood Estimation (MLE), the presence of endogenous variables leads to inconsistent and biased coefficient estimates, as well as standard errors. This is explored in Chang et al (2017)[8]. Linear models are unlikely to account for the expectations-shifting mechanism proposed in section 2.5, where the reliability of expectations of real incomes is directly affected by exchange rate stress. To the extent that unexpected shocks are the dominant sources of large fluctuations in the exchange rate, using our shock dummy as the explanatory variable in the model sufficiently satisfies the conditional independence assumption of the expectation-maximisation procedure. Moreover, situations in which exchange rate becomes a salient policy concern are typically when movements in the exchange rate are abnormally large. The estimates then have a reduced form interpretation, conveniently pinning the expected reaction of employment growth to large autonomous exchange rate shocks under different states.

Building on equations 61 to 67, where the regime-switching depends on the latent financial stress $\mathbf{f}_t$, we estimate following Markov-Switching Model, due to Hamilton (1989)[15].

$$\mathbf{y}_t = \begin{cases} 1\{\epsilon_t < -\hat{\sigma}_\epsilon\beta_1 + \mathbf{X}_t\gamma_1 + \eta_{1t}\}, \ s_t = 1 \\ 1\{\epsilon_t < -\hat{\sigma}_\epsilon\beta_2 + \mathbf{X}_t\gamma_2 + \eta_{2t}\}, \ s_t = 0 \end{cases} \tag{90}$$

The transition matrix contains the probabilities of switching regimes, conditional on the regime of the previous month. We estimate this matrix using the Hamiltonian Filter as per Hamilton (1989)[15] and Hamilton (1990)[16], as part of the MLE procedure.

$$\mathcal{P}_{\mathbf{f}} = \begin{pmatrix} p_{11} & p_{11} \\ p_{21} & p_{22} \end{pmatrix} \tag{91}$$

Variables	Traded	Untraded
	Regime 1	
Shock	0.0537	0.0603****
	(0.067)	(0.0177)
Export-Weighted Global GDP	0.0365****	-0.0022
	(0.0068)	(0.0022)
Export	0.6075**	
	(0.2815)	
Shock*Export-Weighted Global GDP	-0.0176	-0.0203****
	(0.0225)	(0.0058)
Shock*Export	3.0571**	
	(1.4606)	
Export-Weighted Global GDP*Export	-0.2273***	
	(0.0813)	
Shock*Export*Export-Weighted Global GDP	-0.9508**	
	(0.4804)	
Overall 3mma	0.5306****	1.0104****
	(0.1433)	(0.0404)
Constant	-0.1165****	0.015**
	(0.0222)	(0.0073)
Residual S.E.	0.0172	0.0054
Multiple R-squared	0.5799	0.9518
Observations	91	91

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Markov Regime-Switching Model Estimates (Regime 1)

Variables	Traded	Untraded
	Regime 2	
Shock	-0.73809****	0.0292
	(0.0489)	(0.0531)
Export-Weighted Global GDP	-0.0562****	0.0073**
	(0.0068)	(0.0036)
Export	0.2370	
	(0.1891)	
Shock*Export-Weighted Global GDP	0.2276****	-0.0079
	(0.0147)	(0.0181)
Shock*Export	0.1582	
	(0.8906)	
Export-Weighted Global GDP*Export	-0.0273	
	(0.0552)	
Shock*Export*Export-Weighted Global GDP	-0.0327	
	(0.2722)	
Overall 3mma	1.1794****	1.4776****
	(0.0705)	(0.0707)
Constant	0.1888****	-0.0469****
	(0.0227)	(0.0125)
Residual S.E.	0.00719	0.00775
Multiple R-squared	0.9659	0.9494
Observations	91	91

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Markov Regime-Switching Model Estimates (Regime 2)

	Regime 1	Regime 2
Regime 1	0.8535	0.2644
Regime 2	0.1465	0.7356

Table 10: Transition Probabilities — Traded Sector

	Regime 1	Regime 2
Regime 1	0.8931	0.1440
Regime 2	0.1069	0.8560

Table 11: Transition Probabilities — Untraded Sector

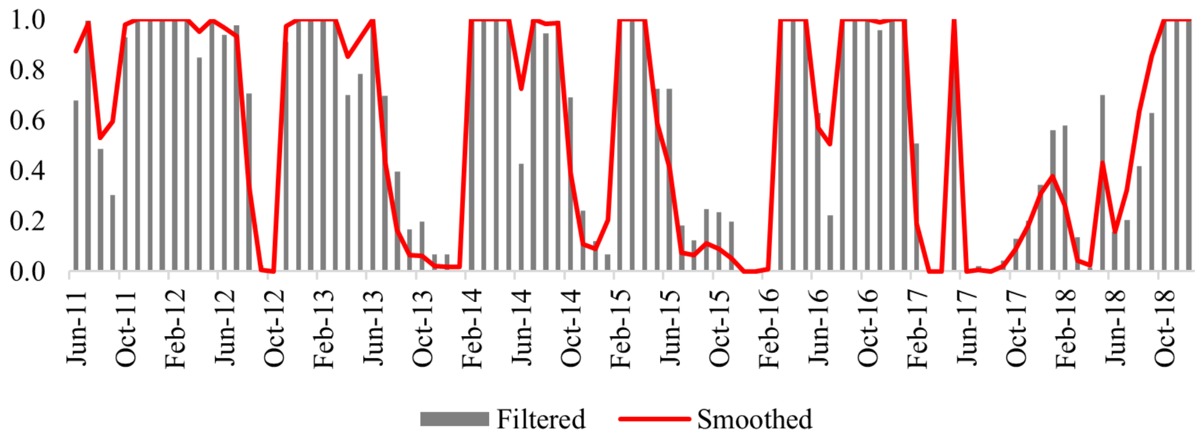

Figure 20: Transition Probabilities — Regime 1 (Tradable Sector)

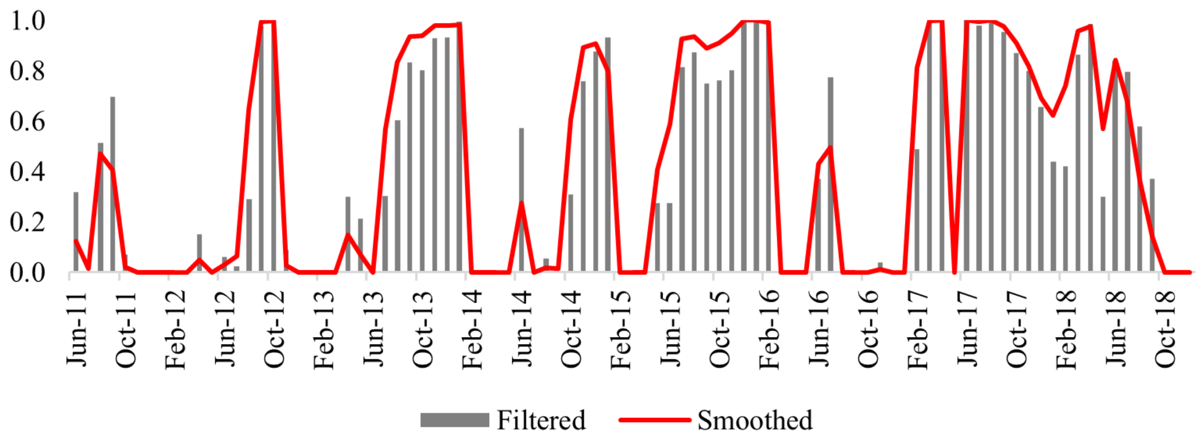

Figure 21: Transition Probabilities — Regime 2 (Tradable Sector)

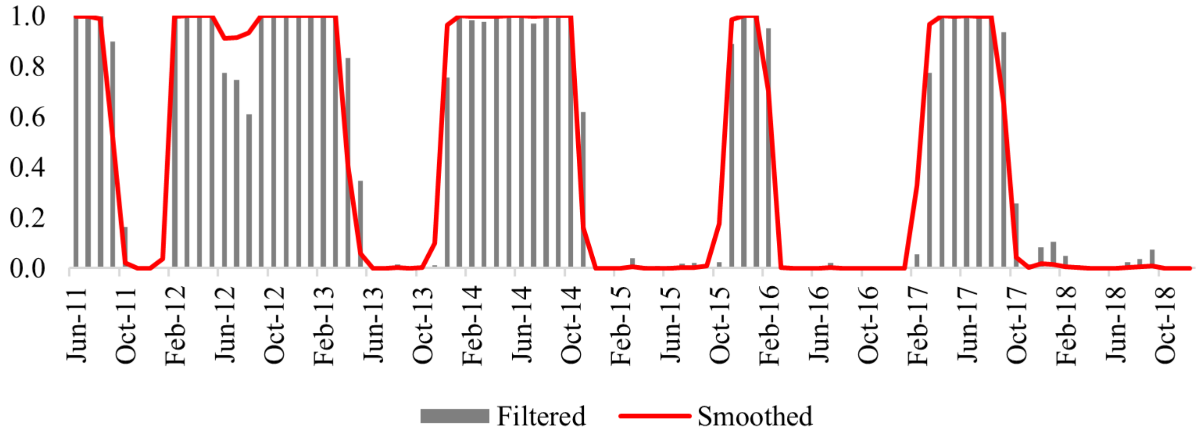

Figure 22: Transition Probabilities — Regime 1 (Non-Tradable Sector)

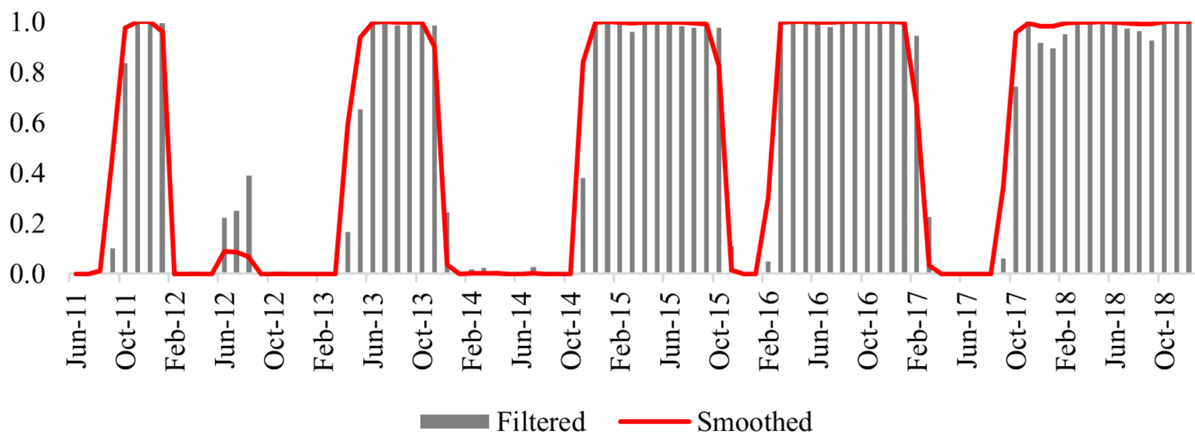

Figure 23: Transition Probabilities — Regime 2 (Non-Tradable Sector)

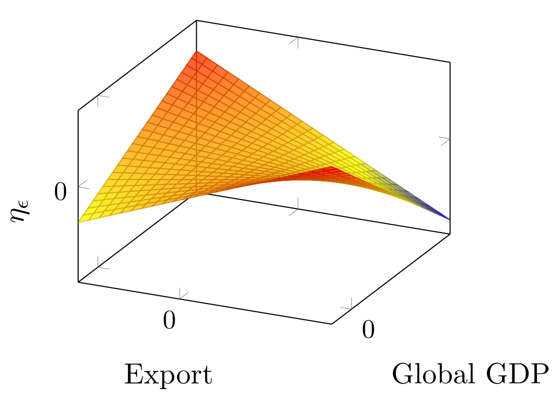

Figure 24: Regime 1 (Tradable)

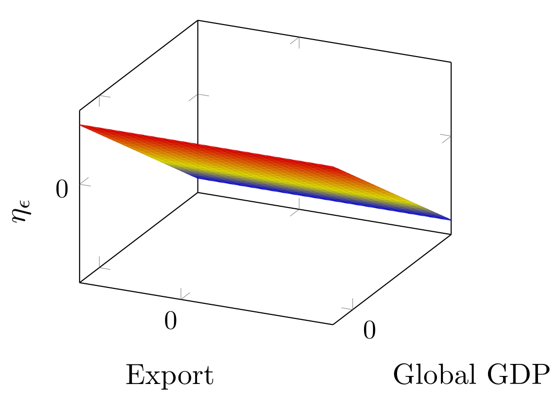

Figure 25: Regime 1 (Non-Tradable)

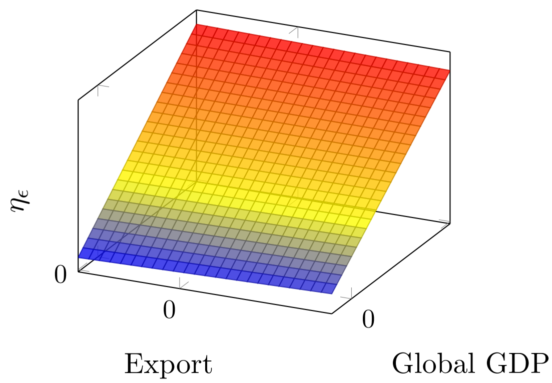

Figure 26: Regime 2 (Tradable)

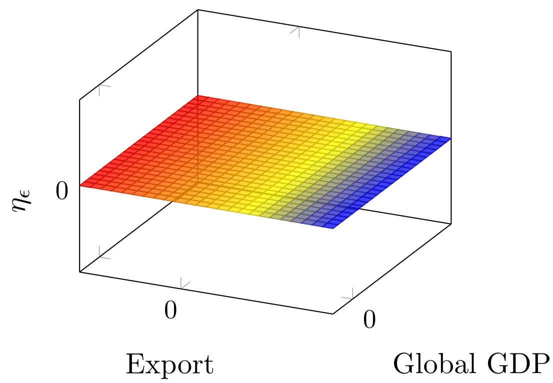

Figure 27: Regime 2 (Non-Tradable)

Tables 8-9 outlines the Markov-Switching Model estimates and standard errors, while tables 10-11 shows the associated estimated transition probabilities for the tradable and non-tradable sectors respectively. Figures 20-23 maps the smooth and filtered probabilities of the economy being in the respective regimes over time. Figures 24 to 27 maps the exchange rate elasticities of employment in the tradable and non-tradable sectors under respective regimes.

From figures 24 and 26, the nonlinearities between the exchange rate elasticity of employment in the tradable sector, export growth and global GDP growth may differ across regimes. In the first regime, employment expands when the exchange rate depreciates in broadly two instances. Firstly, this occurs when both global GDP and export growth are weak. The second occurs, and is more pronounced, when both global GDP and export growth are strong. As the regime switches, the exchange rate elasticity of employment ceases to respond to export growth and is increasing in global GDP growth. However, depreciation is associated with a moderation in employment.

Figure 25 suggests that an exchange rate depreciation is associated with an employment expansion in the non-tradable sector when global GDP growth is high, whilst a moderation when global GDP growth is low. However, as the state switches, employment in the non-tradable sector ceases to respond to fluctuations in global GDP growth, as illustrated in figure 27. Next, I proceed to pin down the operational marginal propensities of both sectors in the respective regimes, given the decadal average export and global GDP growth.

In column 1 of tables 8 and 9, I find precisely estimated coefficients on the shock variable under both regimes for the tradable sector. Conditional on global GDP growth at its mean, employment response to an exchange rate depreciative shock fluctuates between a moderation of 0.06ppt and an acceleration of 0.18ppt between regimes. In column 2 of tables 8 and 9, coefficients on the shock and interaction terms are small, suggesting a fluctuation between a precisely estimated 0.027ppt moderation and an imprecisely estimated, near-zero, 0.002ppt moderation in non-tradable sector employment growth.

Taken together, the results do not contradict our theorised predictions. Under normal circumstances where variability of exchange rate is minimal, despite a large level decline, firms and workers in the tradable sector adjust their expected profit and wages. This follows an expected boom in the manufacturing and mining sectors as their products, mainly priced in USD are export-oriented, become more attractive to consumers in the rest of the world. In the labour market, the need for more employees ensue as firms expand production, whilst more workers proceed to search for jobs in the tradable sector. This leads to an acceleration in employment growth. Under stress regimes, firms and workers fail to form reliable expectations on the trajectories of the exchange rate, consequently that of prices, output, wages and real income. As such, an absence of sufficient adjustments in production and reallocation of resources within the tradable sector leads to a moderation or contraction in employment growth. However, results for the non-tradable sector deviate from the main predictions of our model. Instead of a predicted moderation in the non-tradable sector during normal times, we observe a small, precisely estimated, near-zero acceleration in employment growth. A plausible explanation rests on the Penn-Balassa-Samuelsson Effect. As the tradable sector experiences a boom, households with stakes in these sectors experience an increase in real incomes. An increase in both spending and savings, under reasonable conditions of fixed savings and homothetic demand, follows. Therefore, it is unsurprising to find an increase in demand for non-tradable goods, including that of services. As iterated earlier, households may allocate part of their savings into houses as an additional way of appreciating their newfound wealth. During stress regimes, both empirical and model predictions align. Without facing a direct productivity shock, the non-tradable sector is unlikely to engage in labour market adjustments, as its non-tradable goods and services are priced in the domestic currency, the MYR.

In sum, frictions to gross labour market flows are likely to emerge during periods of market stress in the key pivot of adjustments — the tradable sector — when terms of trade shocks realise. Deviating in part from our main model predictions, the expectations-shifting mechanism is unlikely to be a dominant driver of employment flows within in the non-tradable sector in aggregate. Nevertheless, on the extensive margin, the labour market reactions of the tradable and non-tradable sectors diverge. On the intensive margin, employment growth in the tradable sector diverge under stress and loose states. In particular, employment growth moderates in the former but accelerates in the latter. Taken together, the extensive and intensive results align with theoretical predictions.

6 Conclusion

This paper proposed a mechanism of differential sector-level labour market responses to terms of trade shocks, resting on the bounded ability for agents to form reliable expectations on input and output prices. When financial stress is salient, agents face a veil on their foresight, leading to a failure to form expectations in depreciation episodes. The tradable sector's output, priced in foreign currency, becomes more attractive, translating into a positive productivity shock. However, resources are not reallocated into the tradable sector. The non-tradable sector faces an opposite reality. Without any compensating direct productivity shocks, real incomes fall. The unit value of the domestic currency in terms of imports turns lower, leading to labour market outflows as the opportunity cost of workers staying and firms sustaining output turns higher. At the aggregate level, the plausibility of this channel motivates the possibility of negative or moderating national income growth in episodes of sharp depreciation or devaluation exercises, when financial markets or the latent states of the economy are under stressed conditions.

Bringing theoretical predictions to the empirics, we looked at the sectoral labour market behaviour of Malaysia during 2010-18. Three empirical exercises were undertaken. A SURE estimation provided baseline evidence of differential labour market flows and exchange rate comovements, on both intensive and extensive margins across sectors. Concerns of endogeneity in the exchange rate variable motivated a 3SLS approach. In the theoretical model, we reasoned that when market stress is accommodative, absent of exogenous shocks, exchange rate movements are minimal and can be pinned down by agents. As such, we exploited large depreciation episodes, which should then be attributed to the realisation of external shocks, as an exogenous source of shocks. The fact that these episodes covered the OPEC Oil Price Shock and the Federal Reserve's unwinding of Quantitative Easing (QE) were reassuring. To the extent that instrumental validity holds, evidence on adjustments in the tradable sectors is quantitatively inconclusive. Nevertheless, labour market movements appears to be concentrated in the manufacturing sector. Employment flows in the non-tradable sectors were partly in line with theoretical predictions, and were small in magnitude. The final empirical exercise brings the model to a Markov Switching Model, due to Hamilton (1989)[15]. Once regime switches in the economy are accounted for, theoretical and empirical predictions do not diverge. On the extensive margins, when the economy is in a state of stress, labour market flows diverge between the tradable and non-tradable sectors. On the intensive margin, the tradable sector experiences a reversal in the direction of labour market flows. Furthermore, the non-tradable sector similarly experiences a switch in responsiveness, moving between a small moderation to near-zero employment movements.

This paper lays ground to consider nonlinear reactions to terms of trade shocks at a sectoral level. Efficiency losses are due, in part, to the presence of bounded rational expectations amongst agents when market stress is salient. Evidently, monetary and exchange rate policy reactions to terms of trade shocks become contingent to the state of the economy. However, financial stress may only be part of the determinants of the economy's stress conditions. Further work could be directed at characterising and quantifying these determinants. Importantly, for emerging economies, Assumptions of restricted migration and a lack of shadow labour markets may have skewed our estimates to the conservative side. Whilst data restrictions may be a hindrance to pursue this route for most emerging economies, such work may better identify the dynamics of resource reallocation during depreciation episodes, thereby assisting policymaking in a more transparent and precise manner.

A Appendix

A.1 Financial Stress Index (1999 - 2018)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	Mean	S.D.	Min.	Max.
MSCI EME Equity Index	255	745.9	307.9	240.3	1,337
MSCI EME Currency Index	255	1,263	361.1	615.7	1,726
MSCI EME Financial Sector Equity Index	255	248.9	105.5	77.40	473.0
FTSE Russell USD Sovereign Bonds Index	255	447.8	220.2	116.9	828.6
Equity Index Growth	231	0.0597	0.269	-0.857	0.628
Currency Index Growth	231	0.0451	0.0716	-0.174	0.187
Financial Sector Beta	231	0.988	0.221	0.503	1.721
USD Sovereign Bond Returns Growth	231	0.0885	0.0877	-0.207	0.333
Financial Stress Index	231	-0.00451	1.000	-2.225	3.137
Financial Stress Index (HP Filter)	231	-0.00451	0.591	-1.400	0.903
Financial Stress Index (Hamilton)	219	0.0196	0.175	-0.409	0.524

Table 12: Summary Statistics — Financial Stress

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